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THE

IMMEDIATE CARE OF THE INJURED

11-13-06

BY

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Fully Illustrated

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PREFACE

In the present volume the author has endeavored to prepare a book that would be useful alike to physicians, nurses, and laymen, and at the same time serve as a text-book for the use of First Aid classes. With this object in view the subjects considered have been presented in as simple language as is consistent with clearness, technical terms being omitted as far as possible. Recognizing that illustrations are often of more value than descriptive text in conveying such instruction, a large number—many of them original—have been introduced with a view of affording a clear explanation of points which might otherwise be misunderstood.

To make the book of value to those who may be so situated that medical aid is not promptly available, in addition to the immediate treatment, the subsequent treatment of some of the more important forms of injury has been briefly outlined. In this connection, however, a word of warning is necessary. *First aid should never supersede or take the place of proper medical or surgical attention;* by first aid is meant the *temporary* assistance rendered a sufferer until the arrival of medical aid. To proceed further than this is not only an unwarranted presumption upon the part of the person so doing, but may result in the production of harmful consequences to the injured person. *In all cases a physician should be immediately summoned,* and, in the meantime, the "first aider" should devote his energies to rendering whatever temporary assistance may be within his power.

It will be readily perceived that it is a difficult matter to present such a subject intelligently to those who have no medical knowledge. A previous understanding of the structure and normal workings of the human body is essential for ren-

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dering intelligent assistance in cases of injury and sickness. For this reason, in Part I, the anatomy and physiology of the human body have been briefly outlined.

Part II is devoted to bandaging, dressings, practical remedies, etc., their methods of application being thoroughly explained.

In Part III, how to act and what to do in accidents and emergencies are described in detail. In the preparation of the chapter on "The Transportation of the Injured," contained in this section, the drill regulations of the United States Army Hospital Corps have been followed in the main, with some additions; but the subject has been presented in a simple manner to conform to the rest of the text.

Those who desire to properly equip themselves with a practical knowledge of first aid are strongly advised to take up the subjects in the order presented, carefully studying and practising the methods of applying bandages, dressings, etc. A practical application of the knowledge thus gained may then be made in the treatment of special cases as occasions arise. By intelligently following the directions given anyone should be enabled to render valuable aid in alleviating suffering and, what is in many cases more important, preventing additional injury being done as the result of willing but ignorant attempts on the part of bystanders to "do something."

The writer takes this opportunity of expressing his thanks to Dr. Percy H. Williams for valuable suggestions made in regard to the text, and to others who have assisted in various ways in the preparation of this book.

A. S. M.

66 West Fortieth Street, New York City.
October, 1906.

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PART I.

THE ANATOMY AND PHYSIOLOGY OF THE HUMAN BODY.

CHAPTER I.

ANATOMY OF THE BONES AND JOINTS.

The human body is composed of solid and fluid constituents. The fluids are the blood, the lymph, the chyle, and the secretions of glands and membranes. They contribute the greater proportion of the total weight of the body,—that is, if it were possible to abstract all the fluids from the body the remaining solid constituents would form only about one-quarter of its original weight.

The solids form the framework of the body and are termed the tissues. Some, as bony tissue, are arranged in hard, solid masses and possess great firmness and strength. Some are elongated, forming threads or fibers, as muscular or nervous tissue, each of which possesses its own peculiar properties. Others may be spread out in thin layers, as the epithelial tissue found upon the surface of the skin and lining the internal organs.

These examples of the elementary tissues, while composed of material peculiar to themselves, seldom exist separately in the body, but are grouped together to form compound tissues and organs differing from each other in structure and uses, such as muscles, nerves, blood-vessels, glands, skin, organs of digestion, etc. Muscles, for example, are composed mainly of muscular tissue, but also contain nervous tissue, connective tissue, and blood-vessels.

In the beginning of its development the body consists of but a single round cell composed of a jelly-like substance, termed *protoplasm*, in which lies a nucleus. This primary cell soon divides into two cells, and these two into four, and the four into eight, and so on, until a vast number of cells are formed. As this process of development goes on, the cells change in shape, structure, and character. Some remain round, others become oval, spindle-shaped, or star-shaped, according to the structures they are to produce. The different cells next arrange themselves in groups, and so form the elementary tissues of the body. In this way are formed the blood and lymph, bones, cartilages, muscles, nerves, blood-vessels, connective tissue, the skin, and the various organs with special functions.

Fig. 1.—Bone tied in knot (Raymond).

BONE.

Bone forms the hard framework or skeleton of the body. It is composed of animal matter hardened by impregnation with salts of carbonate and phosphate of lime. In the adult, bone consists of two parts of earthy salts to one part of animal matter. In young children, on the other hand, the earthy salts exist in a smaller proportion, with the result that the bone is more flexible and bends rather than breaks when force is applied. Bones of old persons contain earthy salts in great excess to animal matter. Such bones are very brittle, and fracture may be produced at times from comparatively slight blows. The earthy salts can be easily dissolved by immersing a bone in dilute hydrochloric acid for a few days. Upon removal, the bone will be found to have lost its brittleness and can readily be bent or twisted.

Bones have the function of enveloping and protecting certain parts of the body, as, for example, the chest and skull; of supporting the weight of the trunk, as the bones of the lower extremities; and of acting as levers for locomotion. For these purposes it is essential that the bones should be very strong. As a matter of fact they are among the hardest and toughest structures found in the human body, being able to withstand

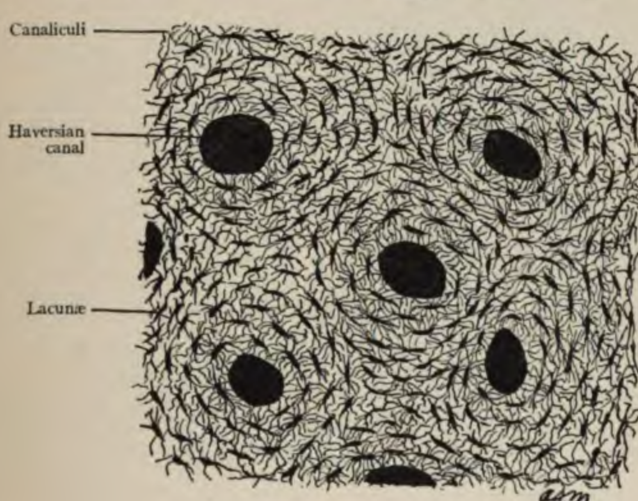

Fig. 2.—Transverse section of bone.

three times as much pressure as an equal bulk of ash or elm and twice as much as oak. They are also elastic, this being especially marked in the ribs, which permits these bones to receive severe blows without breaking.

The Structure of Bones.—Bone is composed of an outer dense layer of *compact tissue* and an inner layer of *spongy* or *cancellous* tissue. These two layers are of practically the same structure, but differ somewhat in their arrangement. On a cross-section of a long bone there will be seen under the micro-

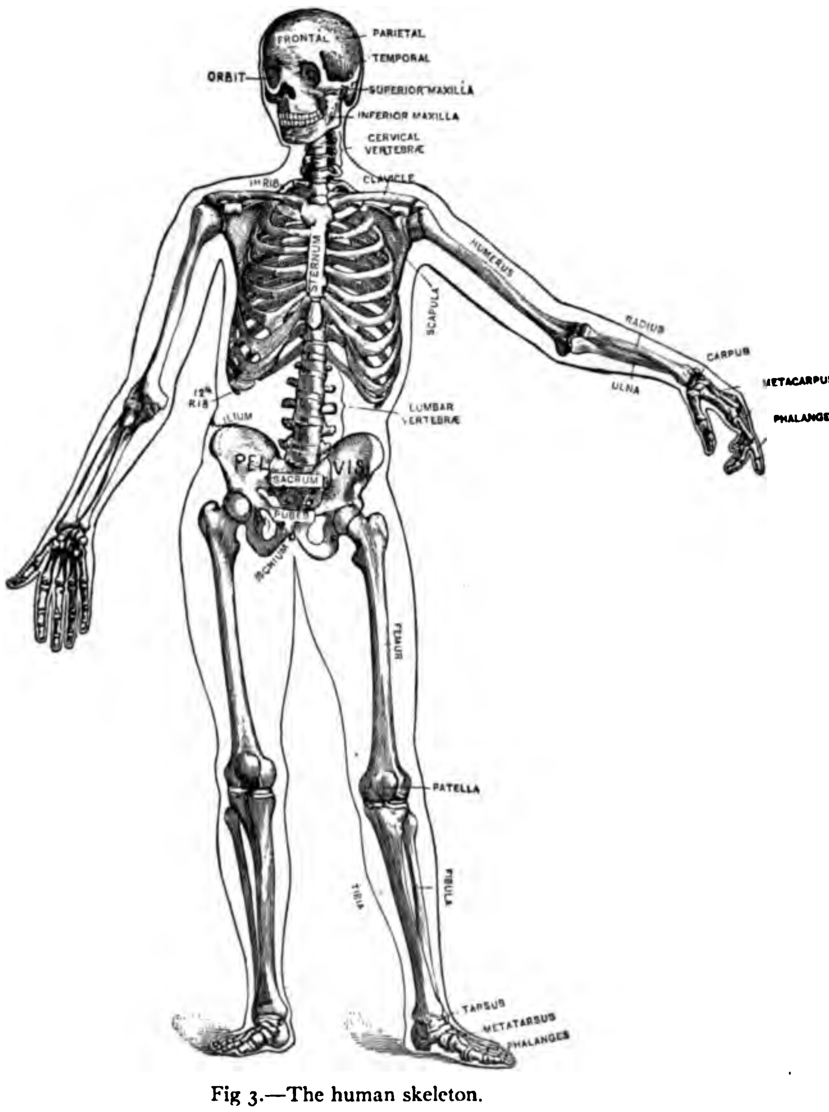

Fig 3.—The human skeleton.

scope a number of openings surrounded by concentric plates of bone tissue, between which are small dark spaces. These central openings represent the *Haversian canals*, and the dark spaces the *lacunæ*, which are connected with the Haversian canals through small threadlike passages termed the *canaliculi*. The Haversian canals, lacunæ, and canaliculi are filled with blood, which they convey to all portions of the bony tissue. Enveloping the exterior of the bone is a layer of fibrous tissue called *periosteum*, which contains many blood-vessels and nerves for the nutrition of the bone.

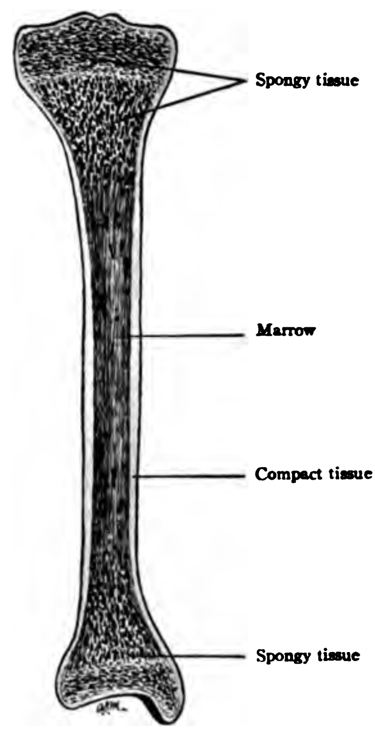

Fig. 4.—Longitudinal section of a long bone.

THE SKELETON.

The skeleton is the bony framework of the body. It serves as a foundation and means of attachment for the soft parts, and protects the vital organs. This framework consists of 200 distinct bones held together by ligaments. The point of union of two bones is termed a *joint*, and, at points where two bones meet or play upon each other, their surfaces are covered with cartilage. Four varieties of bone enter into the formation of the skeleton,—long, short, flat, and irregular bones.

Long bones, such as those of the extremities, serve to support the weight of the trunk and act as levers for the movements of the body. Such bones consist of a cylindrical shaft and two extremities. The extremities are broader than the shaft, thus permitting the bones to be more securely united to each other. They are composed of spongy tissue covered with a thin layer of compact tissue. The shaft is hollow and is filled in its center with *marrow*, while its walls are composed of compact tissue, thus combining lightness with great strength.

Short bones, like those in the wrist or ankle, are intended for strength and compactness in regions not requiring extensive motion. In the wrist the bones are arranged in parallel rows united by ligaments.

Flat bones, such as form the head and sternum, serve more as a protection for the parts they inclose and to provide a broad surface for muscular attachment than for strength. They consist of two compact layers inclosing spongy tissue. In the skull the compact layers are named inner and outer tables, while the spongy layer is termed the *diploë*.

Irregular bones, such as the vertebræ and the bones of the face, have the same structure as other bones, but on account of the lack of definite shape cannot be grouped in any of the other three classes. For descriptive purposes the skeleton is divided into the head, the trunk, and the extremities.

THE HEAD.

The bones composing the head, or skull, with the exception of the lower jaw, are closely united together and form a solid case inclosing the brain. The irregular lines marking the junction of the different bones are spoken of as *sutures*. Sometimes they are mistaken for fractures, so one should be familiar with their exact location. The upper portion of the skull is called the *vertex*, or vault, while the lower part is termed the *base;* the front portion is termed the *sinciput*, and the back part the *occiput*. In the base are numerous openings, or foramina, which transmit blood-vessels and permit the exit of the cranial nerves. The largest of these openings, the *foramen magnum*, gives passage to the spinal cord.

The thickness of the skull is less in women than in men. It also varies in different races, being very thick in the negro. The individual skull is not of equal thickness in all regions; yet, in spite of this, the weight is so evenly adjusted that the head maintains its balance upon the spinal column. The thickest part of the skull is in the region of the occiput; the thinnest over the temporal bones; hence, fractures from blows received directly over the back of the head are rare. All the cranial bones are

Fig. 5.—Side view of the skull (Sobotta).

comparatively thin, yet their arched shape adds greatly to their strength and stability and serves to distribute the force of a blow over a considerable area. Furthermore, many of them are reinforced by ridges extending along their internal surface, so that it requires much more force to produce a fracture than would at first be supposed.

The head may be described as the *cranium*, proper, and the *face*.

The **Cranium** is composed of eight bones—the *frontal bone*, which forms the forehead; the two *parietal bones*, which form the top and upper sides of the head; the two *temporal bones*, which form the lower sides of the head and also a part of the base of the skull; the *occipital bone*, which forms the back of the head and posterior portion of the base of the skull; and the

Fig. 6.—Front view of the skull (Sobotta).

ethmoid and *sphenoid* bones, which enter into the formation of the floor or base of the cranium.

The **Face** is composed of fourteen bones. Half of these enter into the formation of the nose. The two *nasal* bones form the bridge of the nose; the *vomer* divides the nose into two halves; the two *turbinated* bones line its interior; and the two small *lachrymal* bones enter into the formation of a small part of the nose and also contribute to the orbit. The seven remaining bones of the face are the two *malar* bones, which form the prominences of the cheeks; the two *palate* bones, which form a part of the roof of the mouth; the two *superior maxillary* bones, which form the upper jaw and greater part of the roof of the mouth; and the *inferior maxillary* bone, or lower jaw. The upper and lower jaws each contain sixteen teeth.

The *hyoid* bone lies in the neck about on a level with the lower border of the lower jaw. It is a small U-shaped bone giving

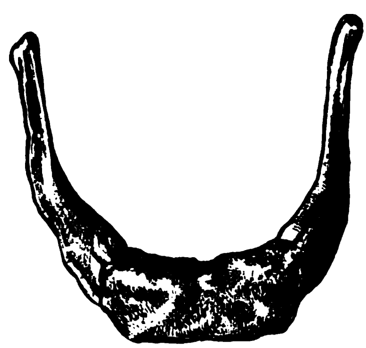

Fig. 7.—The hyoid bone (Toldt).

attachment to the muscles of the tongue and to the ligaments of the larynx. Through pressure applied to the neck, in attempts at strangulation, this bone is sometimes fractured.

THE TRUNK.

The trunk, composed of the spine, thorax, and pelvis, is that portion of the bony skeleton which supports the head and connects the upper and lower limbs. It protects the spinal cord and vital organs of the chest and abdomen.

The **Spine,** or vertebral column, consists of a number of small, irregular bones called *vertebræ*. The vertebræ are all joined together by ligaments to form a long, flexible column.

In this column lies the spinal cord, and upon the upper end of it rests the skull. In front each vertebra is composed of a solid portion, the *body*, and behind consists of an arch, or foramen, through which passes the spinal cord. The vertebræ are separated from each other by discs of cartilage which act in the capacity of springs and tend to break the force of any sudden jar, which might otherwise be transmitted to the head. These intervertebral discs are so soft and elastic that the weight of the body pressing upon them during the day causes them to be somewhat compressed, and so diminishes slightly the height of the person. After a night's rest the full height is again restored. There are 33 vertebræ

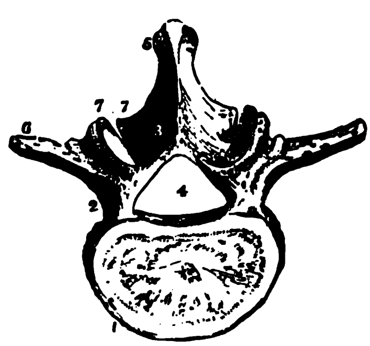

Fig. 8.—A type of vertebra: 1, Body; 2, pedicle; 3, lamina; 4, spinal foramen; 5, spinous process; 6, transverse process; 7, articular process (Leidy).

Fig. 9.—The spinal column (Church).

in the spine. Seven of these enter into the formation of the neck—*cervical vertebræ;* 12 enter into the formation of the back—*dorsal vertebræ;* 5 enter into the formation of the loins—

lumbar vertebræ; 5 form the *sacrum* and 4 form the *coccyx*. The sacral and coccygeal vertebræ are at first distinct bones, but later in adult life the intervening cartilages become ossified or hardened and they thus form by their union two separate bones—the sacrum and the coccyx.

There are three curves in the spinal column: forward at the neck, backward in the region of the chest, and forward again in the lumbar region. These curves are produced by differences in the thickness of the intervertebral cartilages and also by varia-

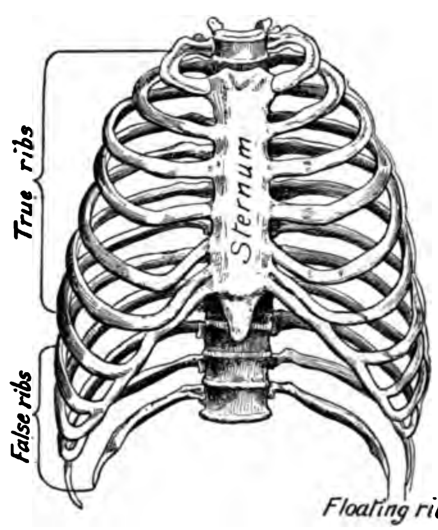

Fig. 10.—Thorax (anterior view) (Ingals).

tions in the thickness of the separate vertebræ. In certain diseases of the spine the curves may be abnormally increased, an increase of the backward curvature producing hump-back.

The **Thorax,** or chest, may be described as a cage formed by the 12 dorsal vertebræ behind, the 12 ribs at the sides, and the sternum in front. It contains and protects the heart and lungs.

The Ribs.—There are 12 ribs on each side, and they form the main part of the chest wall. The ribs are capable of being moved up or down by the attached muscles, and in this way the capacity of the chest is increased or diminished during respiration. The 7 upper ribs are spoken of as the *true ribs*. They are attached behind to the dorsal vertebræ and in front to the sternum by means of intervening cartilages. The remaining 5 are termed *false ribs*. They are all attached behind to the dorsal vertebræ, but in front each of the 3 upper ones is attached to the cartilage of the rib above, instead of to the sternum, while the remaining two have no attachment in front, and are known as *floating ribs*.

The **Sternum,** or breast-bone, is a flat bone, about six inches long, forming the front wall of the chest. It has been compared to a dagger in shape. Above it is broad and shows a depression on each side into which fit the collar-bones. Below it tapers to a point and its sides give attachment to the cartilages of the true ribs.

Penetrating wounds in the region of the sternum are very dangerous, as the heart and great blood-vessels lie almost immediately behind it.

The **Pelvis,** so called on account of its resemblance to a basin, is the bony structure serving to connect the lower extremity with the spinal column. It is composed of 4 bones—the sacrum and coccyx behind, and the 2 innominate bones in front which form its anterior and side walls.

THE EXTREMITIES.

The **Upper Extremity** consists of 32 bones. The arm, forearm, and hand form the upper limb proper, while the clavicle and scapula form the *shoulder-girdle* which serves to connect the arm to the trunk.

The **Clavicle,** or collar-bone, is a curved bone shaped somewhat like the letter S, lying just above the first rib. It articulates with the sternum internally and with the scapula externally, and serves to support the upper limb.

The **Scapula,** or shoulder-blade, is a large, flat, triangular bone, situated back of the chest wall, its broad surface serving

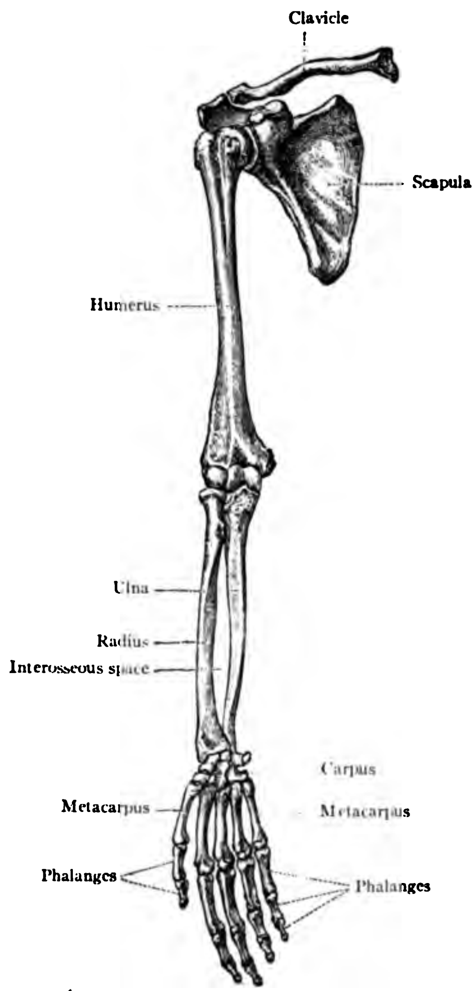

Fig. 11.—Bones of the upper extremity (Toldt).

Fig. 12.—The clavicle, or collar-bone.

for the attachment of muscles passing between it and the chest and arm. It is connected in front with the sternum by means of the clavicle. On its posterior surface is a large ridge, termed the *spine*, which arches forward and terminates in a flat projection overhanging the shoulder-joint, known as the *acromion process*. At its upper and anterior angle is a cup-shaped depression, called the *glenoid* cavity, into which the head of the humerus fits, forming the shoulder-joint.

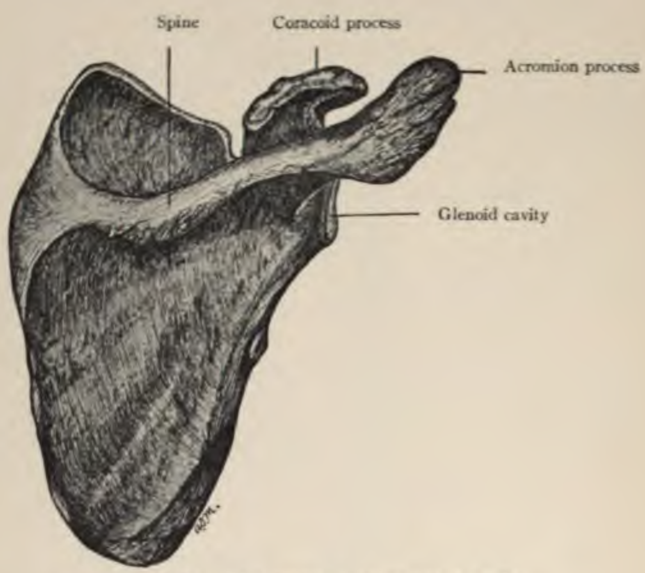

Fig. 13.—The scapula, or shoulder-blade.

The **Humerus,** or arm-bone, is the longest and largest bone of the upper extremity. Its upper end consists of a *head* and an *anatomical neck*. Just below the neck are two rough prominences—the *tuberosities*. The head articulates with the glenoid cavity of the scapula, and with it forms the shoulder-joint. The lower end of the bone is somewhat flattened from before backward and spread out from side to side, and, curving slightly forward, articulates with the bones of the forearm, forming the elbow-joint. The portion of the shaft of the bone immediately below the tuberosities is called the ***surgical neck***, because it is frequently the site of fracture.

The **Forearm** is composed of the radius and the ulna.

The **Radius** lies upon the outer side of the forearm. Its

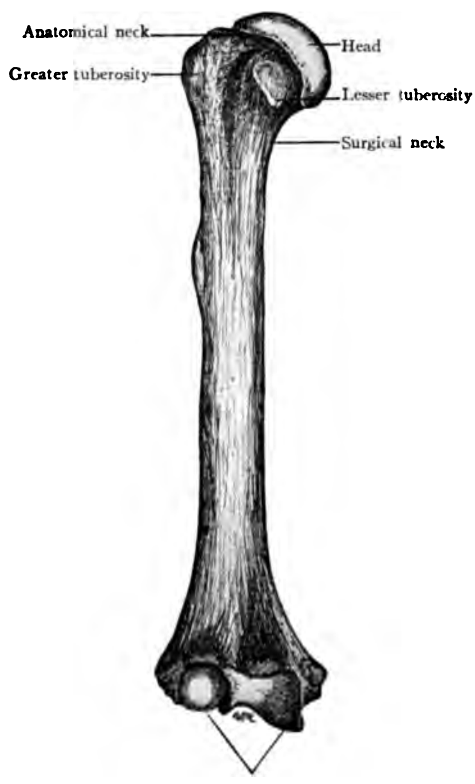

Fig. 14.—The humerus, or arm-bone.

upper extremity is small and forms but a small portion of the elbow-joint. The lower extremity, however, is large and forms the greater part of the wrist-joint.

The **Ulna** lies upon the inner side of the forearm, parallel with the radius. Its upper extremity contributes largely to form the elbow-joint. Extending up and behind the joint is a process which forms the point of the elbow, known as the *olecranon*, or "funny-bone."

The **Hand** is divided into 3 portions: the carpus, which forms the wrist and consists of 8 bones—the *scaphoid*, the

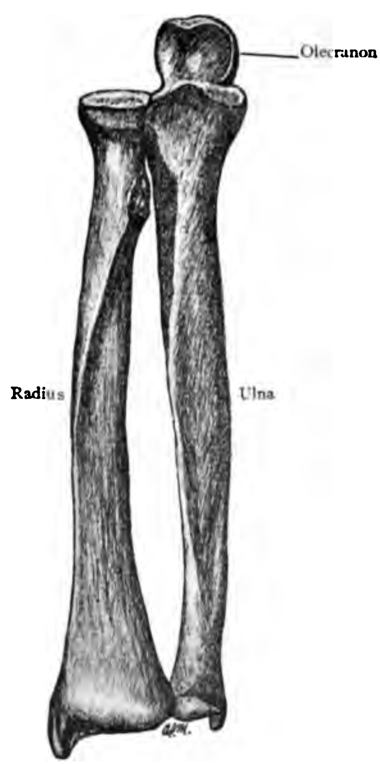

Fig. 15.—The bones of the forearm.

semilunar, the *pisiform*, the *unciform*, the *cuneiform*, the *os magnum*, the *trapezoid*, and the *trapezium;* the metacarpus, consisting of 5 bones; and the phalanges, or finger-bones, 14 in number, 3 for each finger and 2 for the thumb.

The **Lower Extremity** consists of 31 bones which form the thigh, leg, and foot, corresponding to the arm, forearm, and hand of the upper extremity. The lower extremity is connected with the trunk through the os innominatum, or hip-bone, which forms the so-called *pelvic-girdle.*

The **Os Innominatum,** meaning unnamed bone because of the lack of resemblance it bears to any known object, is very irregular in shape, and with its fellow of the opposite side forms the front and side walls of the pelvis. It consists of 3 portions—the *ilium,* the *ischium,* and the *pubes.* Above, the

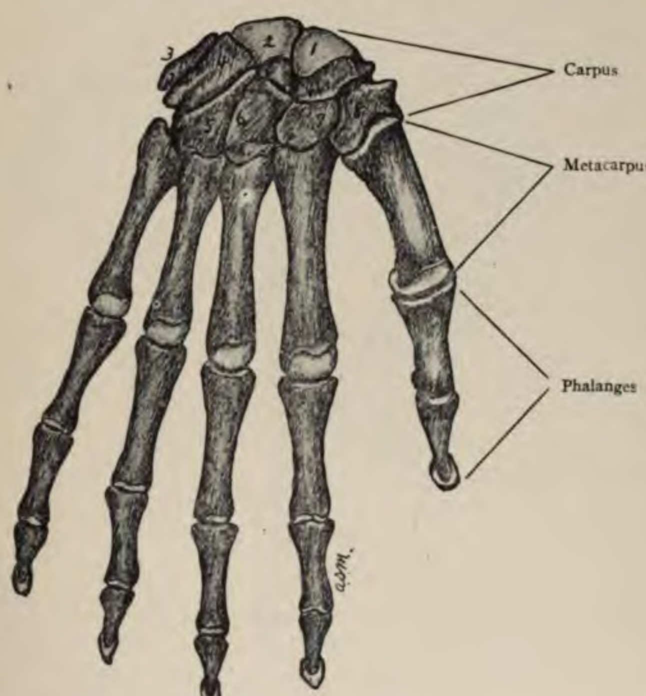

Fig. 16.—Bones of the right hand, dorsal surface. 1, Scaphoid; 2, semilunar; 3, pisiform; 4, cuneiform; 5, unciform; 6, os magnum; 7, trapezoid; 8, trapezium.

bone flares out into a flat, broad surface, the upper border of which is known as the *crest of the ilium.* The anterior portion of this border is called the *anterior superior spine of the*

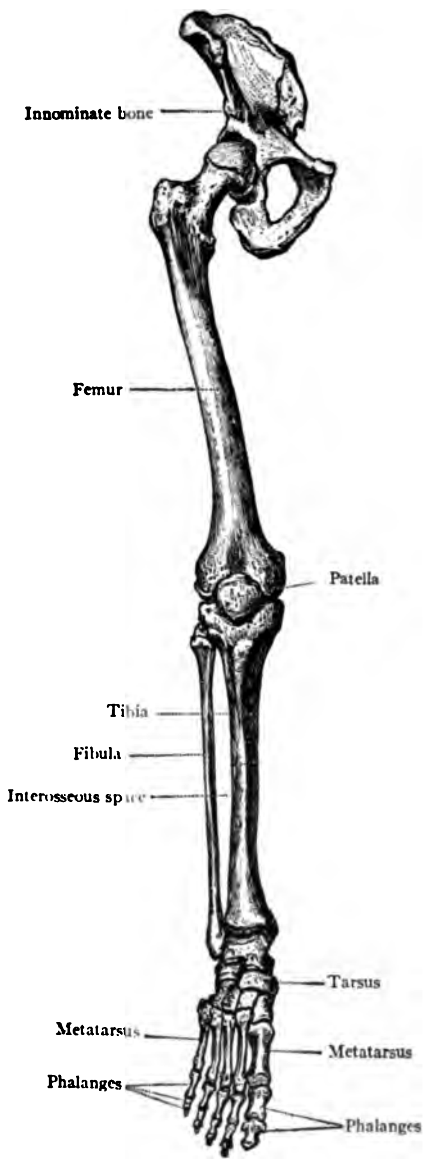

Fig. 17.—Bones of the lower extremity (Toldt).

ilium, a point from which measurements are taken in estimating the shortening in a fracture of the thigh. On the outer surface of the bone is a depression—the *acetabulum*—into which the head of the femur fits. The point of meeting of the two hip-bones in front is known as the *symphysis pubis.*

The **Femur,** or thigh-bone, is the longest, largest, and strongest bone in the body. Upon the upper end of the bone is a round, knob-like projection known as the *head* of the femur, which articulates with the acetabulum of the innominate bone to form

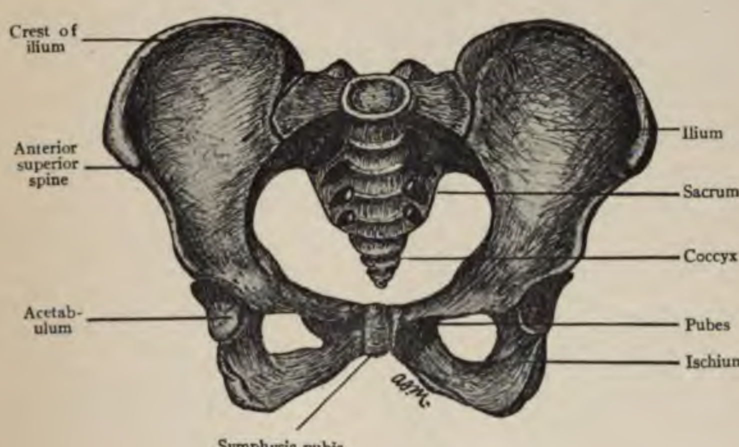

Fig. 18.—The pelvis.

the hip-joint. The head is separated from the shaft of the bone by a constricted portion known as the neck. The neck serves to keep the thigh-bones separated from the trunk, thus preventing the two bones from interfering during the act of walking. The neck of the femur also has to bear the whole weight of the head, trunk, and upper extremities, and its structure is well adapted for this purpose, being composed of a layer of compact tissue externally, and internally of very dense cancellous tissue arranged in arches, which add greatly to the strength of the bone. In old age the bony structure of the neck of the femur becomes weakened and more brittle, and is easily fractured. Below the neck, on the outer and inner sides of the bone, are two rough eminences for the attachment of muscles known respectively

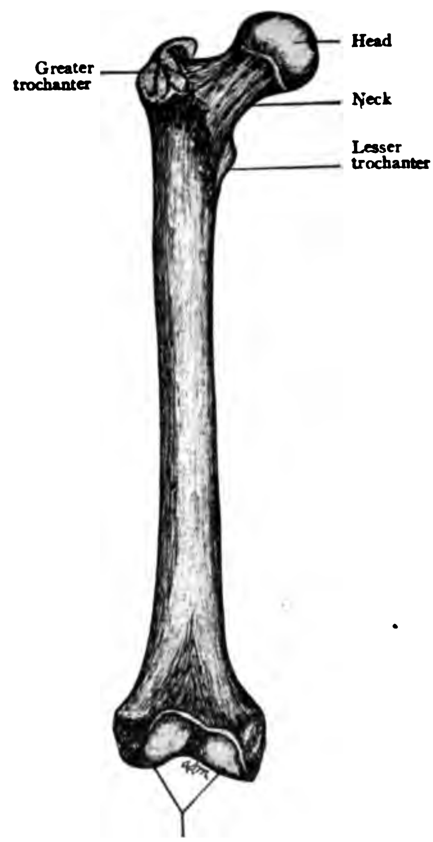

Fig. 19.—The femur, or thigh-bone.

as the *greater* and *lesser trochanters*. The lower extremity of the femur is broad and is divided by a depression into two rounded portions, termed the *condyles*, which rest upon the tibia and enter into the formation of the knee-joint.

The **Leg** consists of three bones—the *tibia*, the *fibula*, and the *patella*.

The **Tibia,** shin, or flute-bone, lies upon the front and inner side of the leg, being next to the femur in size and length. Its upper end is large and expanded into a broad surface known as the *tuberosities*, which support the condyles of the femur and with them form the knee-joint. The lower end is much smaller than the upper, and, on its inner side, the bone extends downward in a projection known as the *inner malleolus*.

The **Fibula,** or splint-bone, is the slender bone lying upon the outer side of the leg. Its upper end does not reach as high as the tibia, nor does it enter into the formation of the knee-joint. The lower extremity, the tip of which is known as the *outer malleolus*, reaches below the level of the tibia and enters into the formation of the ankle-joint.

Fig. 20.—The bones of the leg.

Fig. 21.—The patella, or knee-cap.

The **Patella,** or knee-cap, is the small, flat, somewhat triangular bone in front of the knee-joint.

The **Foot** consists of 26 bones divided into three portions—the *tarsus*, *metatarsus*, and *phalanges*. The bones of the tarsus, 7 in number, form the ankle-joint. They are the *astragalus*, the *os calcis*, the *navicular*, or *scaphoid*, the *cuboid*, the *internal cuneiform*, the *middle cuneiform*, and the *external cuneiform*, the

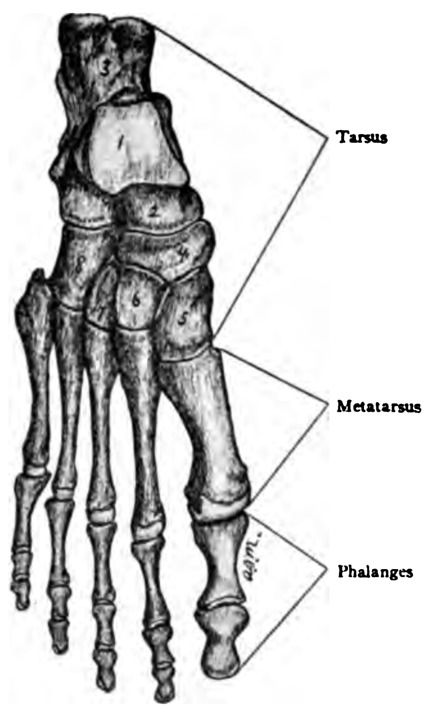

Fig. 22.—Bones of the right foot. 1, Astragalus; 2, head of the astragalus; 3, os calcis; 4, navicular; 5, internal cuneiform; 6, middle cuneiform; 7, external cuneiform; 8, cuboid.

largest of these, the os calcis, forming the heel. The metatarsus, or instep, is composed of 5 bones, while the 14 remaining bones form the phalanges or toes.

THE JOINTS.

The points of union of the different bones forming the skeleton with one another are termed joints, or articulations.

The tissues of which a joint is composed are bone, cartilage, ligaments, and synovial membrane.

Cartilage.—The ends of the bones forming the joints are covered with a smooth, somewhat elastic and very dense tissue, not as hard as bone, termed *cartilage*, or "gristle." It has a pearly blue color, is not supplied with blood-vessels or nerves, and is thickest over the parts of the bone where the pressure is greatest. Cartilage provides the articulating bones with smooth surfaces for motion upon one another without friction; being elastic tissue, it further serves as a buffer against sudden shocks or jars.

Fig. 23.—The hip-joint, showing the ligaments.

Other forms of cartilage are also present in the body, such as the cartilages of the larynx and the intercostal cartilages between the ribs and sternum.

Ligaments are strong, inextensible bands of fibrous tissue having a silvery white appearance. They are very flexible and so allow of free motion in the joints; at the same time they are very tough and inelastic, thus serving to hold the bones of a joint in close apposition.

As the result of great force acting upon a joint, the ligaments may become stretched or torn, producing the common condition of a *sprain;* if the injury is severe enough to allow the articular surfaces to become displaced, the injury is known as a *dislocation.*

Synovial Membrane is a very thin and delicate layer of connective tissue lining that part of the internal surface of the ligaments contained within the joint but not covering the articular surfaces of the bones. This membrane secretes a thick, transparent, slightly reddish fluid which acts as a lubricant for the joint surfaces.

Following an injury to a joint the synovial membrane may become inflamed and the synovial fluid be greatly increased in amount,—a condition called *synovitis*. Such a condition occurring in the knee-joint, for example, results in what is commonly known as "water on the knee."

Varieties of Joints.—There are three chief varieties of joints—immovable joints, joints with limited motion only, and freely movable joints.

Immovable Joints.—In immovable joints, as seen in the

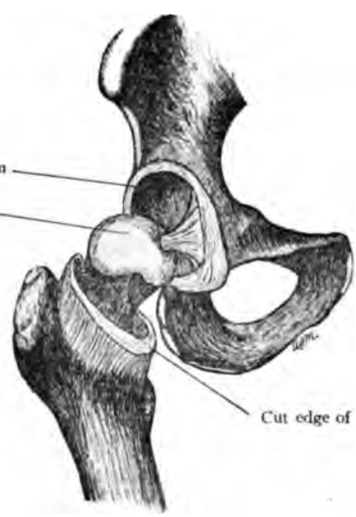

Fig. 24.—The hip-joint laid open.

articulations between the bones of the skull, the bones are, as a rule, firmly united together by immediate contact of bony surfaces, and thus form solid articulations.

Joints with Limited Motion.—Other joints have a limited motion only, as, for example, in the joints of the vertebral column, where the vertebræ are united together by thick plates of very tough and elastic fibro-cartilage, which allows but slight motion between the individual vertebræ, yet permits considerable movement of the column as a whole. The joints between the bones of the pelvis are of this same variety.

Freely Movable Joints.—In all perfect or freely movable joints the opposed bony surfaces are expanded, covered with cartilage, and held together by stout ligaments. These ligaments may be arranged as distinct bands which unite the bony surfaces, or else they may exist as a complete sac or capsule which surrounds the joint. The interior of such a joint is lined with synovial membrane.

Movable joints are further subdivided into gliding, ball-and-socket, hinge, and pivot-joints.

Gliding-joints are found between the small bones of the wrist and ankle, and allow but slight motion.

Ball-and-socket joints permit the freest movement in all directions. They consist of a cup-like cavity into which fits a round head. The hip- and shoulder-joints are examples.

Hinge-joints are found in the elbow, knee, fingers, and toes. Motion is possible in two directions only, backward and forward.

Pivot-joints permit rotation, as, for example, in the joints between the radius and ulna.

Kinds of Movement in Joints.—The following movements are possible in joints, depending on the shape of the articulating surfaces: flexion, extension, abduction, adduction, circumduction, and rotation.

A limb is *flexed* when an angle is formed in it through the bending of a joint; *extended* when this angle is decreased or obliterated. A limb is *abducted** when it is drawn away from the middle line of the body, *adducted* when it is brought to the middle line. *Circumduction* is a combination of movements by which a bone describes a cone-like figure, the apex of which corresponds to a joint, and the base to the free extremity of a bone. *Rotation* is the movement of a bone about a longitudinal axis.

*In the hands and feet the middle phalanx is taken as the central line, hence the thumb would be abducted when drawn away from the middle finger.

CHAPTER II.

THE ANATOMY OF THE SOFT PARTS.

MUSCLES.

Muscles, or the flesh, as they are more commonly called, form a covering for the bony skeleton and give to the body its contour or shape. They also contribute to the formation of certain organs and viscera of the body. In thin persons the outline of the individual muscles can be easily distinguished beneath the skin, but in stout people the spaces between the muscles become so well filled with fat that the outlines of the muscles are obliterated, and the whole body has a more rotund appearance.

Muscles are simply masses of individual muscle fibers. The separate fibers are surrounded by connective tissue and united,

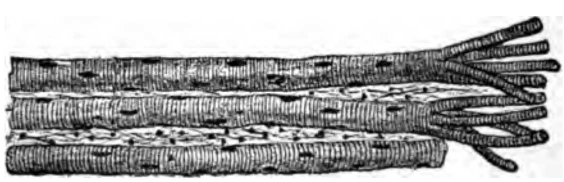

Fig. 25.—Voluntary muscle fibers (Leroy).

together with their blood-vessels, into bundles. These bundles of fibers, in turn, are bound together to form the different muscles which vary in length, breadth, and thickness.

Two varieties of muscles exist in the body: *voluntary* and *involuntary muscles.*

Voluntary Muscles are those which can be made to contract through the power of the will. This is made possible by means of the nerves which supply such muscles, each muscle being in communication with the brain by a separate nerve fiber. These muscles may be attached to the bones, cartilages, ligaments, or

Fig. 26.—The superficial muscles of the body.

skin, either directly or by cords of white fibrous tissue, the *tendons*. Voluntary muscles consist of a large expanded portion, or *belly*, and two extremities, spoken of as the *origin* and *insertion*. The origin of a muscle is its attachment to a fixed or stationary bone, while insertion refers to its attachment to a movable bone.

Involuntary Muscles act independently of the will and without consciousness of their action. They are not attached to bones, but are present in the arteries and veins, intestinal canal, and other internal organs. The fibers of the involuntary muscles are paler in color than those of the voluntary variety and are not arranged in such thick bundles, but form thin bands around the hollow organs.

The Function of Muscle.—Every fiber composing a muscle has the property of shortening in length and increasing in thickness. This is spoken of as the *contraction* of a fiber, and is a property possessed by all muscular tissue to a greater or less extent. When a muscle contracts, its two ends and whatever is attached to these ends are brought nearer together. In this way the bones of the body are made to move, and the body itself can move from place to place and, through its limbs, can perform such work as lifting, carrying, pushing, etc. This is possible because for every muscle which acts upon a limb from one direction there is another muscle with a directly opposite action,—muscles on one side of a limb which bend it, while upon the other side are muscles which extend or straighten the limb. Without this antagonistic action, so to speak, of the muscles the limbs would be utterly useless, and the body would fall in collapse, as the upright position assumed by the human skeleton is maintained simply through the well adjusted and combined action of many different muscles. This action of the different muscles upon the bones is well illustrated in the case of a fractured limb. One fragment of bone will be drawn upon by a certain set of muscles, and the other fragment will be pulled in another direction by other muscles. The result is that, aside from the excessive pain, the limb will be distorted in shape.

The action of the muscles upon the limbs producing locomotion and work is, however, not their only use. Breathing is produced by certain muscles acting upon the chest. Speech is the result of the action of the muscles of the throat, tongue, and larynx. There are small muscles in the orbits attached to the eyes which move the eyeballs, and seeing in different directions is possible. Certain of the muscles in the face produce the expression of emotion; muscles acting upon the mouth, for example, produce the expression of laughing or the appearance of sorrow; others wrinkle the forehead, giving the characteristic appearance of anger; the involuntary muscles in the stomach and intestines contract and propel the food along the alimentary canal. Besides these, many other examples of the varied uses of muscles might be given.

TENDONS.

The tendons are bluish white, glistening cords of fibrous tissue by means of which muscles are united to the bones. They may be round or flat, and vary in length and thickness, the *tendo Achillis*, attached to the heel, being the largest in the body. The tendons are inelastic and cannot contract or pull upon the bones like muscles; in this respect they may be compared to ropes, which are useless in themselves for moving anything unless some power be applied to them. In the case of the tendons, this necessary power is supplied by the contracting muscles.

CONNECTIVE TISSUE.

Surrounding the muscles and organs of the body is a delicate network or mesh of fibrous tissue in which are imbedded fat cells or drops of liquid fat. This is called the *connective tissue*. It not only invests the entire muscular structure of the body with a covering, but it binds the muscles into groups and also dips down between individual muscles, forming a separate sheath or covering for each. In like manner sheaths for the vessels and nerves are formed. More superficially, or immediately beneath the skin, it is found as a continuous layer known as *subcutaneous tissue.* This layer varies greatly in thickness in different individuals and has several important functions,—it gives fullness to the body; it serves as a medium for the passage of the superficial blood-vessels and nerves; it acts as a protection for the subjacent parts; it permits the skin to move freely over the underlying tissues; and it aids in maintaining the bodily warmth.

THE SKIN AND APPENDAGES.

The **Skin,** or integument, forms the external or outermost covering of the body. The appendages are the hair and nails. The skin is the special organ for the sense of touch, and it also

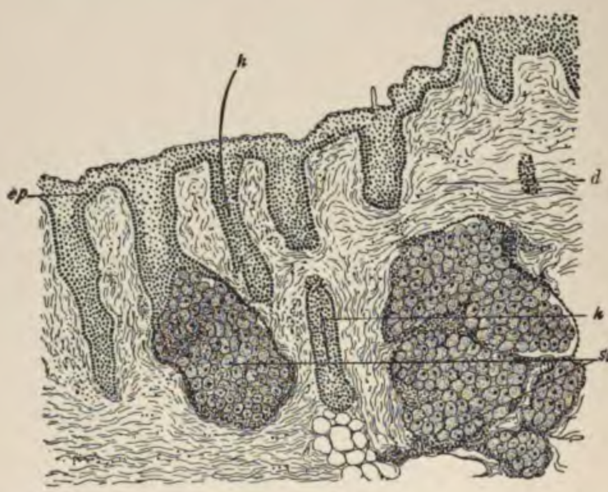

Fig. 27.—Vertical section of skin: *sbg*, Sebaceous glands; *ep*, epidermis; *h*, hair; *d*, derma (Fox).

performs the important function of an excretory organ. It consists of an external layer, the epidermis, and a deep layer, the dermis, or true skin.

The **Epidermis** is composed of layers of epithelial cells which form a horny covering for the true skin. There are neither blood-vessels nor nerves in this layer, and, if cut, it neither bleeds nor causes pain. The sense of touch lies in the papillæ, or nerve endings, situated in the true skin.

The **Dermis** consists of a fibrous matrix in which are imbedded nerves, blood-vessels, sweat glands, hair, hair follicles, and sebaceous glands, and upon its surface are a great number of small, highly sensitive projections, termed *papillæ*.

The *sweat glands* open upon the surface of the skin by small

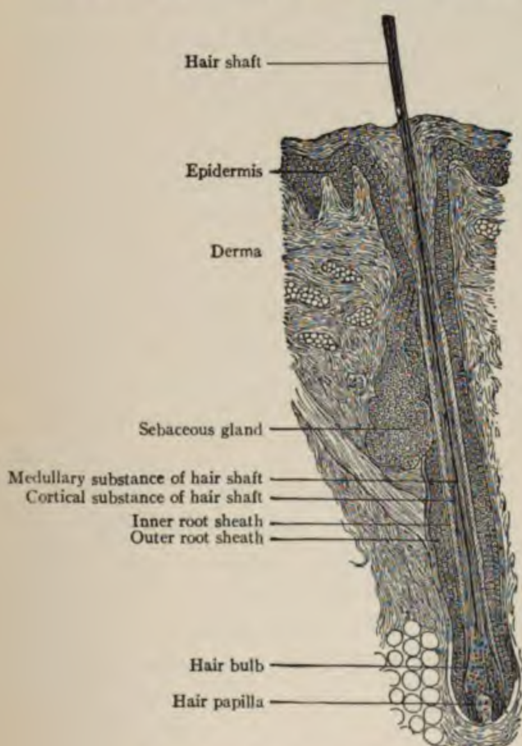

Fig. 28.—Section through hair and follicle (Fox).

ducts, commonly called *pores*. They have the function of separating waste materials and fluids from the blood and excreting them in the form of perspiration. There are over two thousand of these glands in a square inch of skin.

The *sebaceous glands* open upon the surface of the skin, usually at the base of a hair follicle, and secrete a thick fatty material which furnishes oil for the hair and the skin. If the skin is not frequently bathed, the ducts of these glands become plugged with this oily secretion, and dirt readily collects in their openings, giving to the skin the appearance of being studded with small black specks. The sebaceous glands about the face are often thus affected.

The **Nails** are layers of modified epidermis, which become converted into horn as they grow, and finally form a single solid plate of horny material. The true skin beneath likewise becomes modified and forms the *matrix*, or nail bed.

The Hair.—The whole surface of the body, except the palms of the hands and soles of the feet, is covered with a very fine down or, in some regions, by fully developed hair. A hair consists of a long shaft having its origin in a hair sac or hair follicle, and is, like a nail, composed of a modified epidermis. Small, delicate, involuntary muscles are attached to these follicles or sacs, and, when they contract, raise the hair to a perpendicular position. This effect is produced under the influence of cold or fright, and gives rise to what is called "goose flesh" or "hair standing on end."

MUCOUS MEMBRANE.

At the edges of the openings leading to or from the interior of the body the skin ends and its place is taken by a soft, reddish tissue, the *mucous membrane*, which forms a smooth, velvety, and very vascular lining for the interior of the respiratory, digestive, and urinary tracts. The surfaces of all mucous membranes are moistened with a thick secretion, called *mucus*.

SEROUS MEMBRANES.

Serous membranes are thin, glistening layers of tissue which form a lining for some of the cavities of the body and a covering for their contained organs. That lining the abdomen and surrounding its contents is called the *peritoneum;* that lining the chest and surrounding the lungs the *pleura;* and that surrounding the heart the *pericardium.* There is a small quantity of fluid secreted by such membranes, sufficient to moisten its surfaces.

GLANDS.

Scattered all through the body are collections of cells, abundantly supplied with blood-vessels, termed *secretory glands*, whose function is to abstract from the blood certain materials and manufacture from them new substances. Examples of such are found in the glands of the alimentary tract which secrete the digestive fluids.

Some glands simply secrete waste materials which are of no further use to the body. They are known as *excretory glands*, such as the sweat glands of the skin, and the kidneys.

Most of the secreting glands have a duct or small tube leading from them, through which their secretions are discharged and conveyed to the parts they supply.

CHAPTER III.

THE THORACIC AND ABDOMINAL CAVITIES AND THEIR CONTENTS.

The trunk of the body contains in its interior a large cavity divided into two portions by the diaphragm muscle. The upper third of this cavity is called the thorax, or chest, while the lower two-thirds is known as the abdomen, or belly.

THE THORACIC CAVITY.

The thorax is an irregular, cone-shaped cavity, with the apex above and the base below, bounded behind by the twelve dorsal vertebræ, laterally by the twelve ribs and the intercostal muscles, and in front by the sternum and costal cartilages. Below, it is separated by the diaphragm from the abdominal cavity, and above it is closed in by the muscles of the neck. The dorsal vertebræ project into the cavity from behind, partially dividing it into two compartments.

Contents of the Thorax.—The thoracic cavity contains and protects the lungs, heart, esophagus, and trachea.

The **Lungs,** two in number, termed the right and left lung, lie upon either side of the spinal column. Each is contained in a closed sac of serous membrane, the *pleura.*

The apex of each lung rises into the neck for a distance of 1½ inches above the first rib, consequently the lungs may be injured from wounds situated low down in the neck. On the sides, the lower borders of the lungs extend as low as the eighth rib, while behind the lower border corresponds to about the tenth rib. Stab wounds of the chest, at or a little above these levels, would consequently result in injuries to the lungs; but, if the penetrating instrument extended deep enough, it would also enter the abdominal cavity, because the under surfaces of the lungs, resting upon the diaphragm, are concave, and the upper limit of the abdominal cavity is on a higher plane than the lower edges of the lungs.

The **Heart** is situated in the lower and front part of the thorax between the two lungs, the greater portion of it lying upon the left side of the chest. It, too, is surrounded by a closed membranous sac, the *pericardium*.

The heart occupies a position roughly represented upon the chest by a right-angled triangular area, the apex of which is situated at the second rib and its base at the sixth rib. This area near the base measures about 5 inches across, becoming smaller toward the apex, and it extends to about 3½ inches to the left, and 1½ inches to the right, of the median line of the sternum. While a penetrating wound near the middle of the chest above the second rib would thus escape the heart, it might injure the large vessels which lead from it.

The space in the median line not occupied by the heart and lungs is called the *mediastinum*, and contains the *trachea*, or windpipe, the *esophagus*, or gullet, the great vessels of the heart and some nerves.

THE ABDOMINAL CAVITY.

The abdominal cavity, much larger than the thorax, is the barrel-shaped portion of the trunk lying between the diaphragm above and the pelvis below, the part within the pelvis being termed the *pelvic cavity*. Behind it is bounded by the spine, laterally and in front by the muscular wall extending between the thorax and the pelvis. It is lined by a thin serous membrane, the *peritoneum*.

Contents of the Abdominal Cavity.—The abdomen contains a part of the urinary system and nearly all of the digestive organs, the greater part of the cavity being occupied by the closely packed intestines.

The Liver.—Upon the right side of the abdomen just beneath the diaphragm lies the liver and *gall bladder*. The upper surface of the liver reaches as high as the fifth rib, thus being on a higher plane than the lower edges of the lungs. Consequently a

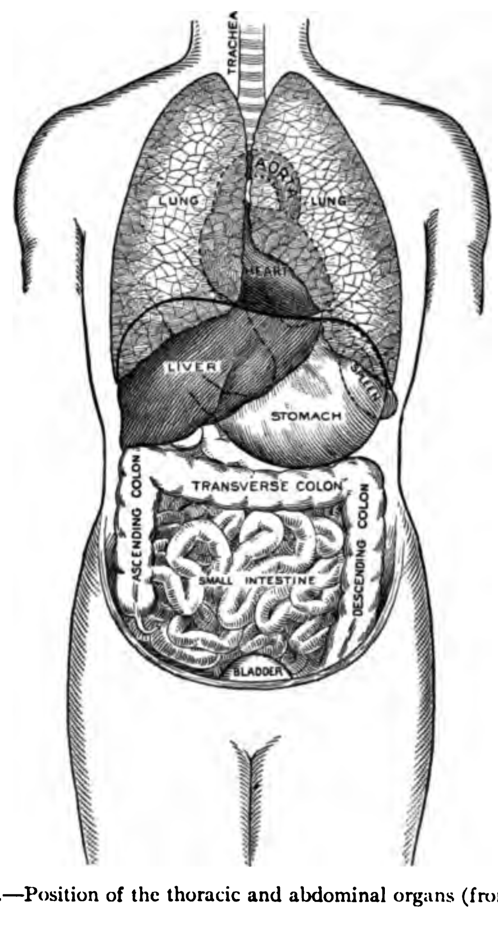

Fig. 29.—Position of the thoracic and abdominal organs (front view).

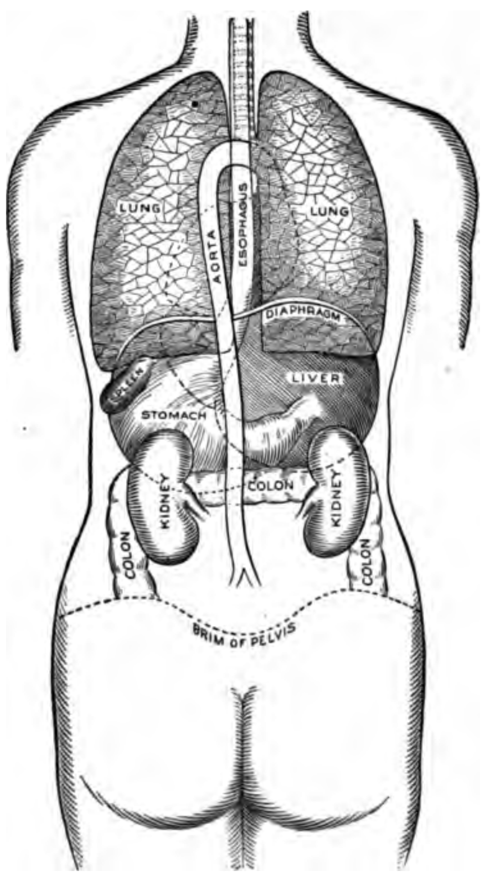

Fig. 30.—Position of the thoracic and abdominal organs (rear view).

knife thrust into the chest on the right side between the sixth and seventh ribs would not only injure the lung, but would also penetrate the diaphragm and liver.

The **Stomach** lies upon the left side of the abdomen beneath the diaphragm and is partly covered by the ribs of that side.

The Spleen.—Just beneath the stomach and well to the left under the ribs is the spleen. Its position corresponds to about the ninth, tenth, and eleventh ribs.

The Kidneys.—On either side of the spinal column, and resting upon the posterior abdominal wall and part of the diaphragm, are the two kidneys, the right being somewhat lower than the left. The upper end of each kidney corresponds to about the eleventh rib behind. The lower ends extend to within about two inches of the crests of the ilia.

The **Pancreas** lies behind the stomach and extends across the abdomen on its posterior wall opposite the second lumbar vertebra.

The **Small Intestine,** divided into the duodenum, jejunum, and ileum, occupies the greater portion of the cavity of the abdomen.

The **Large Intestine** consists of the cecum, ascending colon, transverse colon, descending colon, and rectum.

The *cecum* and *appendix* lie low down upon the right side in the abdomen just above the pelvis; the *ascending colon* passes upward from the cecum on the right side of the abdomen to the under surface of the liver; the *transverse colon* crosses the abdomen beneath the liver and stomach; and the *descending colon* descends upon the left side of the abdomen to the pelvis.

Injury to the intestines from a stab or bullet wound is serious because the intestines, being coiled and closely packed together, are usually damaged in more than one place.

The Contents of the Pelvis.—The **Rectum,** or terminal part of the large intestine, occupies the posterior part of the pelvis.

The **Bladder** occupies the anterior portion of the pelvis.

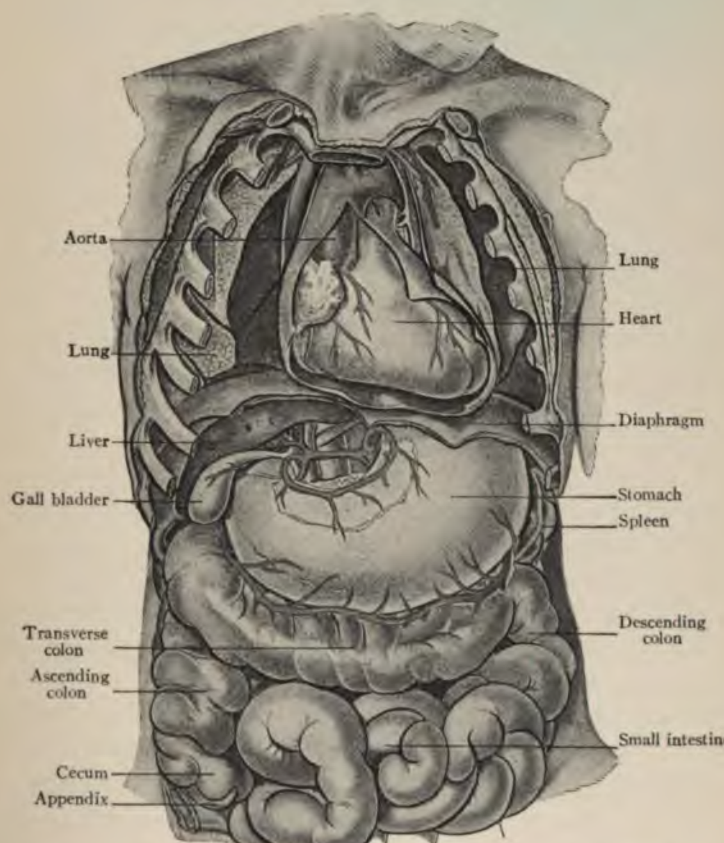

Fig. 31—The contents of the thoracic and abdominal cavity (Maclise).

The Uterus.—In the female, between the bladder and rectum, lie the uterus and its appendages.

In the abdominal cavity, lying upon or in the neighborhood of the spinal column, besides these organs are found certain other structures,—the *aorta*, the main artery of the body; the *inferior vena cava*, the large vein of the trunk; some lymph-vessels; and some nerves.

CHAPTER IV.

THE VASCULAR AND LYMPHATIC SYSTEMS.

THE VASCULAR SYSTEM.

The vascular system consists of a central chamber and a series of closed tubes in which the fluid blood circulates, carrying nourishing material to the tissues and conveying away substances which are no longer useful. The central chamber of this great system is the heart, while the series of tubes are the arteries, capillaries, and veins. The arteries carry blood from the heart to the tissues. Here, by means of the capillaries, the blood gives up its nourishment and becomes laden with waste material. The veins then convey this blood back to the heart and lungs.

THE HEART.

The heart is a hollow, muscular organ which propels the blood through the body. It may be said to be the force-pump of the whole vascular system. It is about five inches long and somewhat conical in shape, lying obliquely in the chest cavity with its base upward and to the right, and with its apex down and to the left. The impulse of the apex against the chest wall, commonly known as the heart-beat, which occurs with each contraction of that organ, can be felt between the fifth and sixth ribs at a point about 3½ inches to the left of the median line. Inclosing the heart is a double membranous sac, the ***pericardium.*** One layer of the pericardium is closely adherent to the surface of the heart muscle, forming a thin, glistening covering, while the other layer loosely surrounds the heart, but is not adherent to its surface. Between the two layers there is a small quantity of fluid. The pericardium by means of its smooth surfaces prevents friction when the heart moves during a contraction.

The Cavities of the Heart.—The heart presents a right and left side, further subdivided into four cavities,—the right and left auricles, and the right and left ventricles.

The **Right Auricle,** composing the upper part of the right side of the heart, occupies the upper and anterior portion of the base. It is a small cavity capable of holding about two ounces of blood. It opens into the right ventricle through the right auriculo-ventricular opening, and upon its posterior wall there are openings for the superior and inferior venæ cavæ.

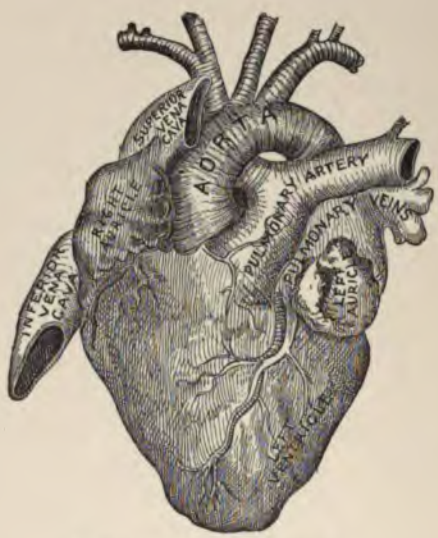

Fig. 32.—The heart (Stoney).

The **Right Ventricle,** composing the lower portion of the right side of the heart, occupies chiefly its right border and anterior surface. It is larger than the right auricle, and its walls are thicker. It resembles an inverted triangle, in the base of which are two openings, the auriculo-ventricular and the pulmonary. The auriculo-ventricular orifice is guarded by a valve consisting of three triangular segments, the *tricuspid valve*, while the pulmonary opening is guarded by a valve composed of three semilunar folds of tissue, the *semilunar valve.*

The inner surface of the ventricle is very irregular, due to a number of muscular projections, the *columnæ carnæ*. Some of these are called the *papillary muscles*, and from these numerous small cords, the *chordæ tendinæ*, extend to each segment of the tricuspid valve.

The **Left Auricle,** composing the upper portion of the left side of the heart, occupies the posterior part of the base. It is

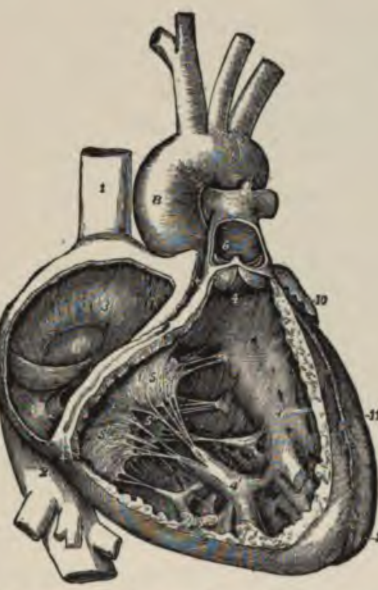

Fig. 33.—Right auricle and ventricle opened: 1, Superior vena cava; 2, inferior vena cava; 3, right auricle; 4, cavity of right ventricle; 4′, papillary muscles; 5′, 5″, 5‴, tricuspid valve; 6, pulmonary artery and semilunar valve; 7, 8, aorta; 10, left auricle; 11, left ventricle (Leidy).

smaller in size than the right auricle, and its walls are thicker. It communicates with the left ventricle by the left auriculo-ventricular opening, and also has four openings for the pulmonary veins.

The **Left Ventricle,** composing the lower portion of the left side of the heart, occupies its left border. It has the same general structure as the right ventricle, only it is longer and more conical, and its walls are three times as thick. At its base are two openings, the left auriculo-ventricular orifice and the aortic. The auriculo-ventricular opening is guarded by a valve consisting of two segments, the *mitral valve*. As in the tricuspid valve, the chordæ tendinæ attach the free edges of these segments to the papillary muscles. The aortic opening is protected by a *semilunar valve*, similar to the one on the right side guarding the pulmonary artery.

Fig. 34.—Left auricle and ventricle, opened and part of their walls removed to show their cavities: 1, Right pulmonary vein cut short; 1′, cavity of left auricle; 3, 3′, thick wall of left ventricle; 4, portion of the same with papillary muscle attached; 5, the other papillary muscles; 6, 6′, the segments of the mitral valve; 7, in aorta is placed over the semilunar valves; 8, pulmonary artery; 10, aorta and its branches (Allen Thomson).

The Working of the Heart. If we simply remember that the heart consists of four cavities—two auricles into which open the great veins of the body, and two ventricles into which the auricles empty and from which spring the two main arteries of the body—we can more readily understand what occurs when the heart is in action, or, in other words, in a state of contraction, for it is solely by the contractions of the heart that the blood is propelled along and kept moving through the vessels of the body. This action is a rhythmical one,—that is, there is a simultaneous contraction of both auricles, followed by a simultaneous contraction of both ventricles, and then a period of rest, during which the heart dilates and again becomes filled with blood, followed by another contraction and a period of rest. The period during which the heart is contracting is known as the *systole*, or beat of the heart, while the period of rest is the ***diastole***.

With each systole the apex of the heart strikes the chest wall, producing the *apex-beat.*

When the auricles contract their cavities become smaller in all directions, and a compression is exerted upon the volume of contained blood, so that it naturally attempts to escape in the direction of least resistance, or toward the openings in the auricles,—those for the large veins and the auriculo-ventricular opening. It is prevented from flowing back into the great veins which brought it to the auricles by the oncoming current of blood, and thus is forced toward the ventricles, in which direction there is but little resistance, as they are at this time empty and easily distended. As the ventricles become filled, the blood distends all portions of the cavities and, working back behind the auriculo-ventricular valves, floats them out, causing them to partially close. Finally, the ventricles become so filled that the auricles are unable to further overcome the resistance offered, and their contractions cease. As soon as this occurs the walls of the auricles relax, and the cavities commence to refill with a fresh supply of blood which flows in from the great veins.

Immediately with the ending of the auricular contractions the ventricles commence to contract, thereby forcing the blood in the direction of least resistance, or back toward the empty auricles. The pressure exerted by the blood upon the auriculo-ventricular valves, however, pushes them closer together, so that they become tightly closed and completely shut the openings they guard. The valves are prevented from being driven back into the auricles by the action of the chordæ tendinæ, which tighten and hold their edges in place. The blood contained in the ventricles is thus compelled to find some other avenue of escape and passes into the large arteries, but to do this it has to overcome considerable resistance, chiefly that offered by the mass of blood in the arteries held back by the semilunar valves. Hence, when we see the amount of work the ventricles are compelled to do, it is easy to understand why they have walls so much thicker than those of the auricles.

With the passage of blood into the large arteries, a slight shock is transmitted through the whole column of blood therein contained, and the vessel walls, being elastic, dilate and become distended by this increased quantity of fluid. This dilatation occurs with each contraction of the ventricles and may be felt in any of the arteries as the *pulse*. As soon as the ventricles cease contracting and forcing blood into the arteries, these dilated vessels, again through their elasticity, return to their normal size. In doing this they squeeze their contents and tend to force the blood along the vessel in both directions; but backward toward the heart any return of blood is prevented by the closure of the semilunar valves, so the column of blood is forced onward into the smaller arterial branches and capillaries.

To summarize the action of the heart briefly, we may say the auricles contract and pour their contents into the ventricles, refilling again as soon as empty; the ventricles then contract, pour their contents into the arterial system, and become again refilled from the auricles. This whole process is called the *cardiac cycle*, and occurs in healthy persons on an average of 72 times a minute.

The Heart Sounds.—If one applies the ear to the chest and listens to the beating heart, two sounds will be heard. First, there is a rather prolonged and muffled sound, immediately followed by a short, sharp one, then a period of rest; then the two sounds are again heard, then a period of rest, and so on. The first sound is supposed to be produced by the closure of the tricuspid and mitral valves and the contractions of the ventricles, while it is certain that the second sound is caused by vibrations produced when the semilunar valves of the aorta and pulmonary artery close.

In certain diseases of the heart the character of the sounds is markedly changed, and the physician is thus able to gain important information as to the conditions which are present.

THE ARTERIES.

The arteries are cylindrical elastic tubes which convey the blood from the heart to every portion of the body. The arterial system, beginning at the heart, consists of two large vessels, the aorta, and the pulmonary artery. By continually dividing and subdividing innumerable branches are formed which permeate all portions of the body and, getting smaller and smaller, finally terminate as minute vessels called *capillaries*. Thus all the arteries of the body, except the pulmonary artery supplying the lungs, are indirectly branches of one large vessel, the aorta.

The only valves found in arteries are those already described

Fig. 35.—Cross-section of an artery and two veins showing the relative thickness of the walls. a, Inner; b, middle; c, outer coat.

guarding the openings of the aorta and pulmonary artery in the heart.

Structure of an Artery.—An artery is composed of three coats,—an inner, middle, and outer tunic.

The *inner coat* is composed of a single layer of epithelial cells lying on a membrane of elastic tissue. It forms a smooth lining for the vessel, and thus lessens the friction between the circulating blood and the vessel wall.

The *middle coat* is composed of involuntary muscular tissue and yellow elastic tissue. The elastic tissue gives elasticity to the vessel wall and enables it to return to its normal size after it has been distended. The elastic tissue varies greatly in amount, in the large arteries forming the greater part of the middle coat, while in the smaller vessels it is absent, the muscular coat alone being present.

The *outer coat* is composed of fibrous tissue which contributes to the strength of the vessel.

Surrounding the artery is a sheath of connective tissue in which lie the nerves and blood-vessels which supply the artery itself. The thickness of the arterial coats causes the vessel to remain distended when empty, thereby differing from the veins, which under like conditions collapse.

The Course and Distribution of the Arteries.—The **Aorta,** the largest blood-vessel of the body, begins at the left ventricle and passes upward in the form of an arch upon the right side of the spine, then crosses it and passes down upon the left side, gradually approaching the median line of the body. It then passes through the diaphragm into the abdomen, and, after giving off branches to the thoracic and abdominal viscera, terminates opposite the fourth lumbar vertebra by dividing into the two common iliac branches.

The **Innominate Artery,** 1½ inches in length, arises from the aorta, passes up in front and to the right of the trachea and divides into the right common carotid and the right subclavian arteries.

The Common Carotid Artery.—The right arises from the innominate, the left from the arch of the aorta. Both vessels pass up the side of the neck and, opposite the upper border of the thyroid cartilage (a part of the larynx), divide into an internal and external branch.

The **Internal Carotid** passes up the side of the neck, lying deeply imbedded in the muscles, and enters the skull through the temporal bone to supply the brain and eyes.

The **External Carotid** passes up the side of the neck more superficially than the internal to supply the larynx, pharynx, tongue, face, nose, ears, and scalp. The *facial* branch crosses

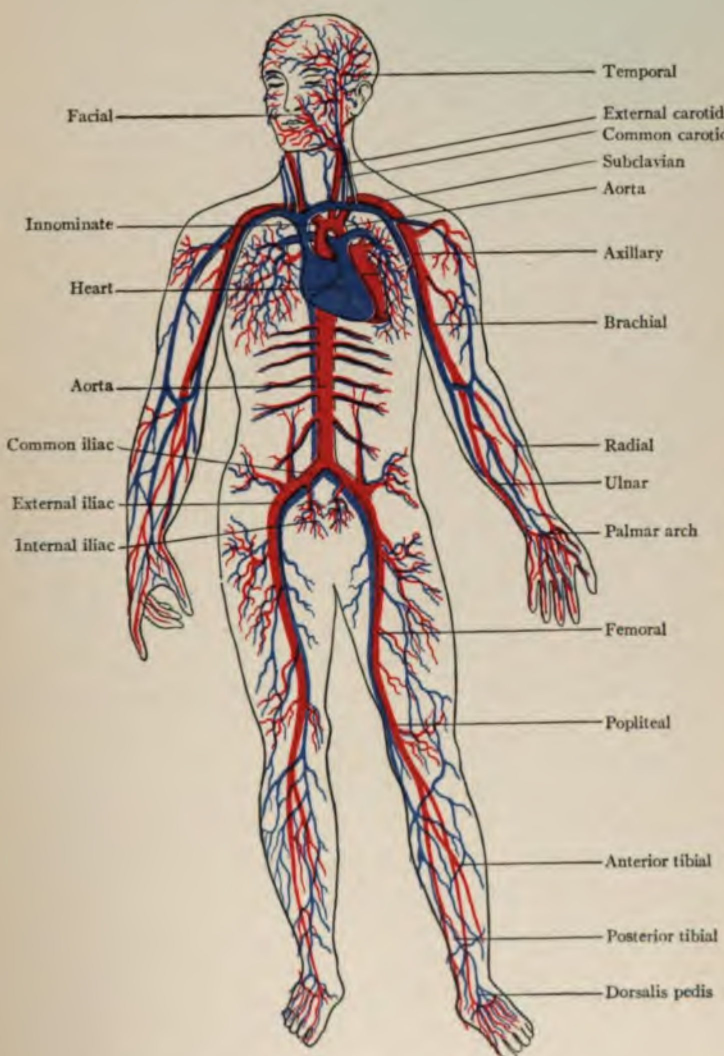

Fig. 36.—The principal arteries and veins of the body.

the lower jaw in a groove about one inch in front of the angle of the jaw. The *temporal* branch passes up just in front of the ear to supply the sides of the scalp. The *occipital* branch passes upward upon the back of the head to supply the back of the scalp.

The **Subclavian Artery,** arising from the innominate upon the right and from the aorta upon the left, passes up over the first rib but under the clavicle in the form of an arch.

The **Axillary Artery** is a continuation of the subclavian. It extends from the lower border of the first rib to the lower border of the armpit.

The **Brachial Artery,** a continuation of the axillary, passes down the inner side of the arm along the inner border of the biceps muscle, gradually approaching the anterior portion of the arm. An inch below the elbow it divides into the ulnar and radial arteries.

The **Ulnar Artery** passes along the inner side of the forearm to the wrist, and unites with a branch of the radial to form the superficial palmar arch.

The **Radial Artery** passes down the outer side of the forearm to the wrist where it winds around the thumb and, passing through the muscles between the thumb and first finger, appears upon the palm to form with a branch from the ulnar the deep palmar arch.

The **Common Iliac Arteries,** termed the right and the left, are the terminal branches of the abdominal aorta. They are about two inches long and extend from the fourth lumbar vertebra to the upper border of the sacrum, where they divide into internal and external branches.

The **Internal Iliac** enters the pelvis, the contents of which it supplies.

The **External Iliac** passes down along the brim of the pelvis to the thigh, where it becomes the femoral.

The **Femoral Artery** passes down the front of the thigh, its course being represented by the upper two-thirds of a line extending from the center of the groin to the internal condyle of the femur, and then, piercing the thigh muscles, it gradually works its way to the back of the thigh.

The **Popliteal Artery** is a continuation of the femoral. It passes obliquely downward and outward behind the knee-joint and, below the knee, divides into anterior and posterior tibial branches.

The **Anterior Tibial** pierces the muscles of the leg and appears upon its anterior surface. It then passes down the outer side of the leg, lying deeply in the muscles above and becoming superficial as it nears the ankle joint. At the bend of the ankle it becomes the *dorsalis pedis artery*, and as such supplies the anterior portion of the foot.

The **Posterior Tibial** extends down the back and inner side of the leg to the ankle, here lying superficially between the heel and internal malleolus. It finally enters the sole of the foot and divides into internal and external plantar branches.

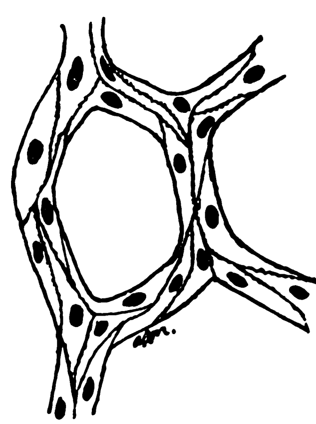

Fig. 37.—Diagram of capillaries.

THE CAPILLARIES.

Capillaries (meaning hair-like) are minute vessels, lying deep in the tissues, interposed between the arteries and veins. They are but a small fraction of an inch in length, and their walls, composed of but a single layer of epithelial cells, are so thin that the contents of the vessel can readily pass out between the cells into the tissues in which they lie. In this way an interchange of nutrient and waste material is effected between the blood and tissues.

THE VEINS.

The veins begin where the capillaries end, and are tubes which convey the blood, previously carried by the arteries to the capillaries, back to the heart. They are more numerous than the arteries, usually two veins accompanying each artery. The smaller veins from different parts of the body continually unite to form larger veins which eventually terminate in the superior or inferior vena cava, and they, in turn, empty into the right auricle of the heart. Veins differ from arteries in having upon their inner surface many small pouch-like projections, termed *valves*. They prevent a backward flow of blood toward the capillaries during muscular contraction.

The Structure of a Vein.—Like an artery, a vein has three coats,—inner, middle, and outer.

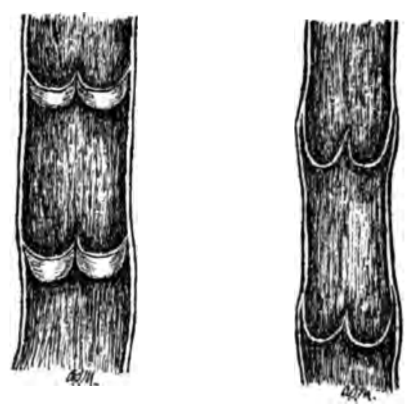

Fig. 38.—Diagram of the valves of veins.

The *inner* and *outer coats* have the same structure as is found in the corresponding coats of an artery.

The *middle coat* is much thinner than that of an artery and contains but little elastic tissue.

Veins are usually inclosed in the same sheath of connective tissue as the artery they accompany and, like arteries, are supplied by nerves and blood-vessels.

THE BLOOD.

The blood is the fluid which circulates through the heart and blood-vessels. It is an alkaline, opaque fluid with a specific gravity of 1055, comprising $\frac{1}{13}$ of the total body weight. In the arteries it has a bright red or scarlet color, due to the presence of oxygen, but when it reaches the veins it is dark red or blue, due to the presence of carbonic acid gas.

The blood is usually called the nutritive fluid of the body, because it supplies the tissues with certain nutritive material which has been separated and prepared by the digestive organs from the food taken into the stomach. It also has the function of carrying oxygen from the lungs to the tissues and of removing from the body through the lungs, kidneys, and skin, waste matter

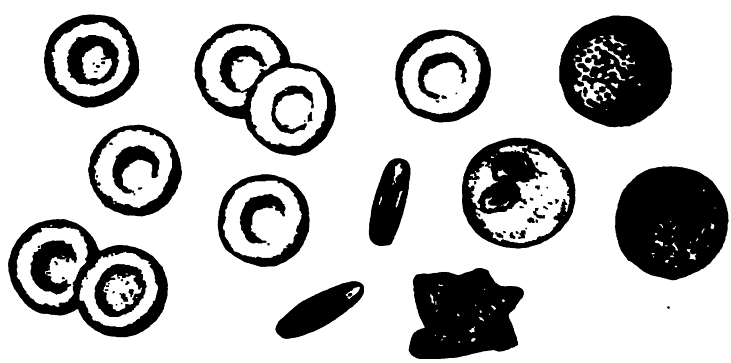

Fig. 39.—Blood cells. Red cells upon the left, white cells upon the right (A. S. M.).

which is of no further use. Finally, it aids in maintaining and equalizing the bodily temperature.

It is composed of a liquid portion, called the *plasma*, in which are suspended innumerable small bodies, the *red* and the *white blood-corpuscles*.

The **red, or colored corpuscles,** when examined under the microscope, are seen as bi-concave circular discs or cells. There are four to five million of these cells in one cubic millimeter, being many times more abundant than the white corpuscles. They are larger than some of the capillaries, but, being very flexible and elastic bodies, can adapt themselves to the size of the vessel through which they have to pass and then resume their normal size. The red coloring of these corpuscles is due to a pigment, called *hemoglobin*, which also has the power of easily combining with oxygen. The red cells may be said to be the oxygen-carrying bodies of the blood.

The **white, or colorless corpuscles,** also called leukocytes, are larger, fewer in number, and more irregular in outline than the red ones. They possess the power of *ameboid movement*, which consists in a constant alteration in the shape of a cell as the result of contractions taking place in its substance. By means of this power, the cell is able to move from place to place. It accomplishes this by sending out a portion of its body in the form of a projection, then moving the rest of its body up to this, and sending out another process farther along in the same direction.

Coagulation of the Blood.—When blood is drawn from the body and allowed to stand a few moments, it becomes solidified and forms a jelly-like mass. This is known as *coagulation*, or clotting, and is due to the formation in the plasma of a fibrous-looking material, called *fibrin*. The blood corpuscles become entangled in this fibrin, and thus is formed a semisolid mass consisting of the plasma, fibrin, and blood-corpuscles. If this clot is placed in a vessel and allowed to stand, a clear, yellowish fluid will be seen to appear, in which lies the original clot, but now somewhat changed in character, appearing shrunken and smaller than before. The fluid, thus formed, is called the *serum*, and its presence is due to the contraction of the fibrin in the clot, which has shrunk and squeezed out the fluid portion. Coagulation of the blood is nature's means for arresting a hemorrhage. It does not occur when the blood is circulating in healthy living vessels, but is hastened by exposure to air and contact with injured or diseased tissues, extreme heat or cold, and foreign bodies. The old-fashioned but very effective means of stopping hemorrhage by applying cobwebs or lint scrapings to a bleeding wound causes a clot to form, because these substances act as foreign bodies.

Circulation of the Blood.—The fact that the blood is a fluid and that it moves continually in a definite direction through the body was discovered in 1616 by William Harvey, of England, the belief previous to that time being that the blood-vessels contained air. The course taken by the blood in its passage through the body is known as the circulation, and it may be described as follows:

The venous blood, collected by the superior and inferior venæ cavæ from the tissues of the body into the right auricle, as

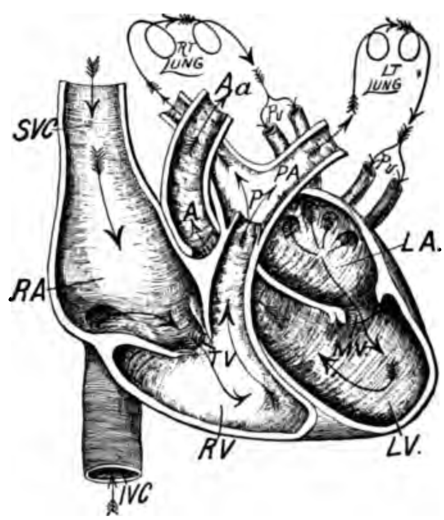

Fig. 40.—The circulation of the blood through the heart: *IVC*, Inferior vena cava; *SVC*, superior vena cava; *RA*, right auricle; *TV*, tricuspid valves; *RV*, right ventricle; *P*, pulmonary valves; *PA*, pulmonary artery; *Pv*, pulmonary veins; *LA*, left auricle; *MV*, mitral valves; *LV*, left ventricle; *A*, aortic valves; *Aa*, arch of aorta (Page).

the result of the contraction of that cavity, passes through the right auriculo-ventricular opening into the right ventricle. By the contraction of the right ventricle it is forced into the pulmonary artery, which, first dividing into two main branches and then into innumerable small branches, carries it to the capillaries surrounding the air-vesicles in the lungs. Here the blood gives up its carbonic acid and receives a fresh supply of oxygen, and thus changes from venous to arterial blood. From the lungs the arterial blood is collected by the four pulmonary veins and is conveyed to the left auricle. By the contraction of this cavity it is forced through the left auriculo-ventricular opening into the left ventricle. The left ventricle then contracts and propels the blood into the aorta, thence into the smaller branches, and finally into the capillaries of the body, where it gives up the nourishment with which it is laden and receives waste matter from the tissues. The blood again becomes venous, and, collected by the many veins of the body, is eventually brought back to the right auricle, having made a complete circuit of the entire vascular system.

The Lymphatic System.

The lymphatic system is a very extensive network of small vessels distributed generally through the body, but profusely abundant beneath the skin and mucous membranes. Its circulating fluid is called the *lymph*. Lymphatics resemble veins in their structure and, likewise, have numerous valves. In addition there are present at various points along the course of the lymph-vessels small round bodies, the *lymph-nodes*, through which the lymph has to circulate. It will be remembered that when the blood circulates through the thin-walled capillaries portions of it pass from the capillaries into the tissues, which it bathes, supplying them with nourishment. Some of this fluid, now called lymph, is first collected into lymph-spaces surrounding the tissues, and then enters small lymphatic vessels which lead from these spaces. These small vessels continually unite into larger and larger vessels, and eventually form two large vessels, one of which, called the *thoracic duct*, passes up through the abdomen and thorax; the other—the *right lymphatic duct*—is found upon the right side low down in the neck; both of these vessels empty into the large veins at the root of the neck.

There is no special apparatus to make the lymph circulate, as a heart, such as propels the blood through the vascular system. It, however, moves continually from the periphery to the center of the body, being apparently sucked along. The movement of this fluid in one direction occurs because the pressure where the lymphatics take origin in the tissues is greater than in the large lymph-vessels; likewise the muscular contractions of the body, such as occur in the hollow organs and in the limbs, press upon the lymph-vessels and squeeze their contents out toward the larger vessels. The valves of the lymphatics prevent the lymph from flowing back again when these contractions cease, and the empty vessels are again immediately filled by more lymph flowing in from the tissues.

The **Lymph** is a clear, colorless fluid, consisting of a liquid portion, and a solid portion containing white blood-cells, or leukocytes. It differs from the blood in having no red cells and in being composed of a very small proportion of solid matter. During digestion the lymph found in the lymphatics of the intestinal canal becomes laden with fats and, as a result, changes somewhat in character, having now a milk-white appearance and being known as the *chyle.*

The **Lymph-nodes** are important in that they effect certain changes in the lymph, it being found that the lymph after passing through these nodes contains a greater number of leukocytes; furthermore, the nodes act as filters or sieves for the whole lymphatic system, thus preventing infection from extending through these vessels to other parts of the body.

CHAPTER V.

THE RESPIRATORY SYSTEM.

Respiration, or breathing, is the process by which oxygen is taken into the body and carbonic acid expelled. Oxygen is necessary if the body is to perform its proper functions; in fact, it is absolutely essential for the maintenance of life. Taken into the lungs in the inspired air, it combines with the blood and is carried by this fluid to every portion of the body, uniting with the tissues of the body and the food as it is digested, and so permitting these materials to be oxidized or burned up. As oxidation proceeds, energy and heat are liberated, the energy being necessary in furnishing the body with power for work, and the heat to maintain the bodily warmth. As a further result of this oxidation or combustion a poisonous substance, ***carbonic acid***, is formed in the tissues and blood, and some of this gas is expelled from the body with each expiration in the exhaled air.

Now, air deprived of oxygen or containing an excess of carbonic acid is equally dangerous. The prolonged breathing of such air will produce a condition of asphyxia, and finally death, just as certainly as would strangulation. Before this extreme condition occurs, however, such symptoms as headache, restlessness, and languor will be complained of by the person affected, symptoms which anyone who has been compelled to remain in an overcrowded and poorly ventilated room for any length of time may have felt. Continually breathing stale or stuffy air weakens a person and lowers the vitality, even in those who are more or less accustomed to it. To insure good health it is estimated that a person requires at least 1,000 cubic feet of air space, and the air breathed should be frequently replenished through proper ventilation.

The essential part of respiration, the interchange of carbonic acid gas and oxygen which is effected between the blood and the air, takes place in the lungs. In the previous chapter we have seen how the blood makes its way to the lungs, but to understand the manner in which air is transmitted to these organs some knowledge of the arrangement and mechanism of the respiratory apparatus will be necessary.

The respiratory apparatus consists of the *nose*, *pharynx*, *trachea*, *bronchi*, and *lungs*.

THE NOSE.

The nose is not only an organ of respiration, but is also the organ of the sense of smell. Its interior is divided by a septum, consisting of bone and cartilage, into two irregular cavities, the

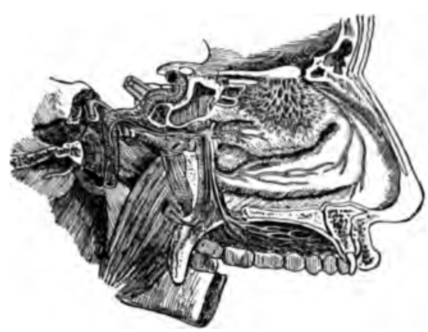

Fig. 41.—The interior of the nose, showing the nerve supply.

nasal fossæ. These fossæ are occupied chiefly by spongy, scroll-shaped projections of thin bone, known as the *turbinated bones*, and are lined by a thick mucous membrane which serves to warm and moisten the inhaled air. The interior of the nose is also richly supplied by the *olfactory nerves*, which are endowed with a delicate sense of smell, and thus protect the lungs from the inhalation of harmful gases. Externally the nasal fossæ open as the two nostrils, and posteriorly they lead into the pharynx through the posterior nares.

THE PHARYNX.

The pharynx, which is also a part of the alimentary tract, is the conical musculo-membranous sac forming the throat, or back part of the mouth. It is 4½ inches long, and is lined with a mucous membrane which is continuous with that of the nose and mouth. Extending from the lower portion of the pharynx are the openings for the esophagus and the larynx, the former lying behind and the latter in front.

THE LARYNX.

The larynx, while forming a part of the respiratory apparatus, has a more specialized function of being the principal organ of voice. It is a sort of triangular box, broad above, and narrowed below where it leads into the trachea, composed of a number of cartilages and lined by mucous membrane. Its projection can readily be felt through the skin as "Adam's apple." The middle of the larynx is constricted and has a slit-like opening, the *glottis*, the edges of which are formed by sharp fibrous bands, the *vocal cords*. The glottis is opened and closed by the action of certain muscles. When it becomes narrowed, the vocal cords are tightened and vibrations are caused during expiration which produce the voice, but ordinarily the glottis lies open, and no sound is produced by the inflow and outflow of the air. The glottis is covered by a piece of cartilage, the *epiglottis*, which acts as a lid and prevents particles of food and foreign bodies entering the larynx.

Fig. 42.—Interior of the larynx. 1, Epiglottis; 2, vocal cord; 3, cavity of the trachea (after Testut).

THE TRACHEA.

The trachea, or windpipe, is a cylindrical tube 4½ inches long extending from the larynx down the front of the neck into the thorax, where it divides into the two bronchi. It is prevented from collapsing by the presence of from fifteen to twenty in-

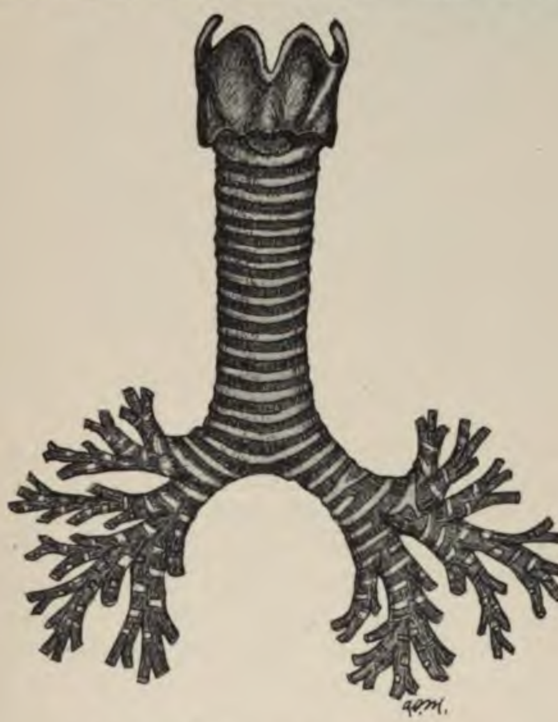

Fig. 43.—Larynx, trachea, and bronchi.

complete rings of cartilage, placed one above the other and united by a thin membrane. The posterior wall, where these rings fail to meet, is formed by muscular tissue, and the whole tube is lined by mucous membrane.

THE BRONCHI.

The bronchi are the two branches resulting from the bifurcation of the trachea, and have the same general structure as the trachea. They enter the lungs and divide into a great number of small branches, the ***bronchial tubes***, which in turn divide and subdivide and finally terminate in an innumerable number of small dilated cavities or pouches, the ***air vesicles***, or ***alveoli***. The bronchi and bronchial tubes are lined with a form of mucous membrane, known as *ciliated*, which is different from that found in the rest of the respiratory tract. It has numerous hair-like projections on its surface, which wave and produce a current in a direction away from the air cells, and so tend to prevent the entrance of dust and foreign matter into the lungs.

Fig. 44.—Diagrammatic representation of the termination of a bronchial tube in a group of infundibula: *B*, bronchial tube; *LB*, bronchiole; *A*, atrium; *I*, infundibulum; *C*, alveoli (Nancrede).

THE LUNGS.

The lungs in the adult are two slate-colored, cone-shaped organs composed of a soft, spongy, and very elastic tissue. They occupy the greater part of the chest cavity, lying on either side of the spinal column and resting on the diaphragm, but separated from each other by the heart. The left lung is divided by a deep fissure into an upper and lower lobe, while the right lung is further subdivided by a second fissure, and consists of an upper, middle, and lower lobe. The lungs are united on the inner surfaces to the heart and trachea by the ***roots***, which consist of the bronchi, pulmonary arteries and veins, lymphatics, small vessels, and nerves. Each lung is inclosed in a double membranous sac, similar to the pericardium, called ***the pleura***, one layer of which is closely adherent to the lung itself, while the other layer lines the chest cavity. Between the two layers is a small quantity of fluid which serves to moisten their surfaces and prevent friction when the lung moves during respiration.

The lung substance is composed chiefly of the air vesicles, or

Fig. 45.—The lungs (Maclise).

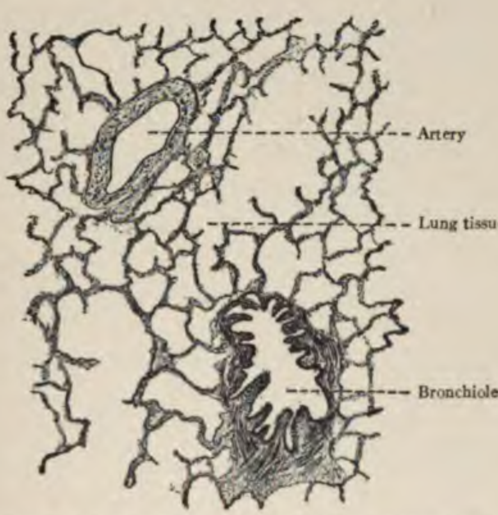

Fig. 46.—Section of cat's lung. × 52 (Böhm and Davidoff).

cells. These cells are $\frac{1}{70}$ to $\frac{1}{200}$ of an inch in diameter, with walls consisting of a very thin layer of epithelial cells, surrounding which are the wide, thin-walled pulmonary capillaries. By this arrangement only a very delicate membrane is interposed between the air on one side and the blood on the other, so that an exchange of gases between the two readily occurs. The venous blood is brought to the capillaries, where it expels into the air cells the carbonic acid and waste matter with which it is laden and receives in return a new supply of oxygen, which is taken up by the red blood cells. Thus a change from venous to arterial blood is effected.

RESPIRATION.

The respiratory act is involuntary, and occurs in a healthy individual ordinarily from 16 to 20 times a minute. It is composed of two distinct periods: *inspiration*, and *expiration*.

Inspiration is the process by which the lungs become inflated with air through the expansion of the thorax. This enlargement is accomplished mainly by the contraction of the diaphragm and intercostal muscles. The diaphragm at rest is somewhat convex and projects like a dome into the thorax. When it contracts, it becomes flattened, and thus the capacity of the thorax in the vertical diameter is increased. When the intercostal muscles contract the ribs are elevated, and the capacity of the thorax in its antero-posterior diameter is increased. As the chest cavity enlarges, the lungs, being elastic, readily follow the chest wall and become distended, at the same time drawing in through the trachea sufficient air to fill them. In this way, with each inspiration, the lungs are furnished with a fresh supply of air from which the blood can abstract the oxygen.

Expiration is the process of expulsion of air from the lungs, and it is effected by the return of the thorax to its original size. It is purely a passive act,—that is, the diaphragm and intercostal muscles simply relax, and the extra air taken in during inspiration is driven out. The expired air from which the oxygen has been abstracted is, however, laden with carbonic acid and waste matter given off by the blood.

The fullest capacity of the lungs is 330 cubic inches of air, but during ordinary quiet respiration the inflow and outflow of air, known as *tidal* air, amounts to only 30 cubic inches. The lungs, however, never become entirely empty or collapse, and there remains about 75 to 100 cubic inches of air that cannot be gotten rid of, called *residual air.* In addition, there is in the chest after ordinary expiration about the same quantity of air, the *reserve* or *supplemental air*, which can only be expelled by forced expiration. Thus, after an ordinary inspiration the lungs contain about 230 cubic inches of air. By taking a very deep and long inspiration about 100 cubic inches more air can be added, and this is called the *complemental air.*

The expired air differs from that inspired in that it is always of the temperature of the body, no matter how cold the outside atmosphere may be, so that with each expiration a certain amount of heat is lost. In this way the body is continually being cooled off. Again, the expired air is always saturated with moisture, no matter how dry the inspired air may have been. Expired air also contains less oxygen and more carbonic acid than that inspired, and is, in addition, laden with other waste material, the result of decomposition occurring in the body.

Modified Respiration.—There are besides the act of respiration certain other acts connected either with inspiration or expiration which may be called modified respirations. Some of these are involuntary like the act of respiration itself, while others are distinctly voluntary and under the control of the will. The modified acts of respiration include coughing, sneezing, crying, laughing, sobbing, sighing, yawning, snoring, and hiccough.

Coughing consists mainly in a forcible expiration. An inspiration is first taken, followed immediately by a sudden, sharp expiration by which the glottis is forcibly thrown open, the air, driven out through the mouth, producing a characteristic sound. In this way foreign bodies may be expelled from the respiratory tract.

Sneezing is a reflex act caused by irritation of the nerves of the nose. As in coughing, it consists of an inspiration followed by a sudden expiration. The air, however, is driven out through the nose, with the result that any foreign substances which may be there are forcibly expelled.

Crying and **laughing** both consist of an inspirtation followed by several repeated expirations. They differ from coughing in that the vocal cords vibrate with each expiration, producing various sounds. Crying differs from laughing in the expression of the face, and the former is accompanied by a profuse flow of tears.

Sobbing consists in a number of spasmodic inspirations, followed by a prolonged expiration.

Sighing is simply a long, deep inspiration followed by a long expiration.

Yawning.—The mouth is stretched wide open, and a long inspiration is taken, followed by a short expiration with which is usually produced a peculiar sound.

Snoring is caused by air respired through the open mouth, producing vibrations in the relaxed soft palate.

Hiccough is due to spasmodic contractions of the diaphragm resulting in a sudden inspiration, which is abruptly shut off by the closure of the glottis.

CHAPTER VI.

THE DIGESTIVE SYSTEM.

The digestive system, or alimentary apparatus, may be considered as consisting primarily of a long tube, composed of the mouth, esophagus, stomach, and intestines, with the salivary glands, liver, and pancreas as accessory organs. This tube,

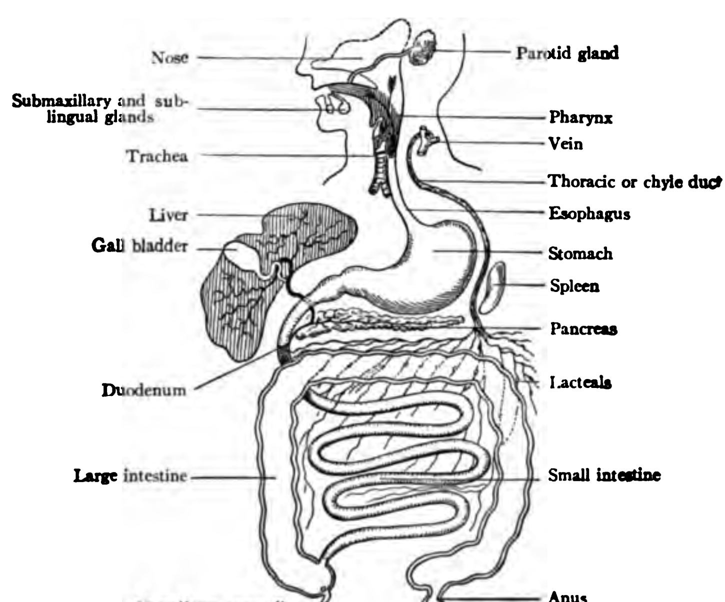

Fig. 47.—General scheme of the digestive tract, with the chief glands opening into it (Raymond).

or *alimentary canal* as it is called, is about thirty feet long, of varying diameters, and extends from the mouth to the fundament, or anus. Its purpose or function is, first, to separate the nutritious material from the food and expel the residue from the body; second, to convert the nutritious matter into such a form that it can be easily absorbed into the blood and be utilized by the tissues. To understand how this is accomplished, some knowledge of the separate parts forming this complicated apparatus will be necessary.

THE MOUTH.

The mouth is an oval cavity forming the commencement of the alimentary canal, bounded in front by the lips, laterally by the cheeks, behind by the soft palate and opening of the pharynx, above by the hard palate, and below by the floor of the mouth and tongue. Suspended from the posterior border of the hard palate, and narrowing the opening between the mouth and pharynx, is a movable fold of mucous membrane, the *soft palate;* hanging down from its center is a small projection, the *uvula;* while extending from the uvula downward and forward on either side are two folds of tissue known as the pillars of the soft palate. Between these two pillars are located the *tonsils.* Separated from the cavity of the mouth by the soft palate is the pharynx or throat, which has already been described (page 75).

The **tongue** lies in the floor of the mouth, and is composed of muscular fibers in which are imbedded nerves and blood-vessels. Its base is attached to the adjacent structures by numerous muscles, while its tip and sides are free. Extending from the under surface of the tongue to the floor of the mouth is a fold of mucous membrane called the *frenum.* The surface of the tongue is covered by a mucous membrane which is raised into numerous projections, the *papillæ,* and gives to the tongue its rough appearance, while beneath the mucous membrane lie the so-called taste-buds.

The Teeth.—Extending around inside the lips and cheeks in the form of an arch are the two rows of teeth, thirty-two in all, consisting of two incisors, one canine, two bicuspids, and three molars in each half of each jaw. The teeth have as a special function the grinding up of food, and are necessarily made up of a very strong, dense substance called *dentin,* which is covered with *enamel,* the hardest substance in the body. Each tooth consists of three portions: the fang, or root, which lies imbedded in the jaw; the crown, or that portion projecting beyond the gums; and the neck, or that portion between the root and crown. Particles of food, if allowed to collect between the teeth, undergo fermentation and produce an acid which eats away the enamel, so that, unless the teeth are kept properly cleaned, decay is very apt to follow.

The interior of the mouth is lined with a mucous membrane

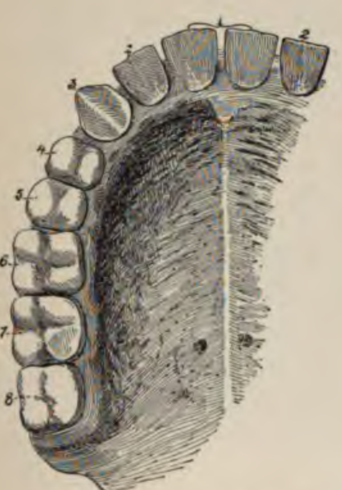

Fig. 48.—The teeth: 1, Median incisors; 2, lateral incisors; 3, canine; 4, first bicuspid; 5, second bicuspid; 6, first molar; 7, second molar; 8, wisdom tooth (after Testut).

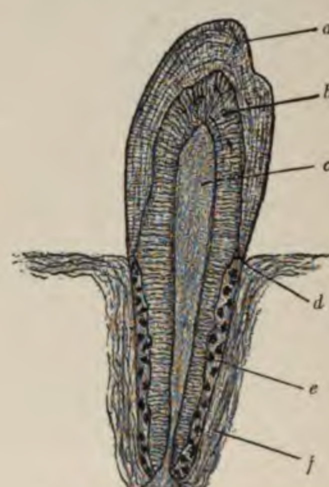

Fig. 49.—Tooth: *a*, Enamel; *b*, dentin; *c*, pulp cavity; *d*, junction of enamel and cementum; *e*, cementum; *f*, alveolar periosteum (Leroy).

which contains numerous glands, the ***buccal glands***, and has openings upon its surface for the ducts of the salivary glands. These consist of three pairs of large glands: the parotid, submaxillary, and sublingual.

The Salivary Glands.—The *parotid gland*, the largest of the three salivary glands, lies upon the side of the face just below and in front of the ear. It has a duct about 2½ inches long which runs along between the muscles of the face and opens upon the inner surface of the cheek near the second molar tooth of the upper jaw.

The *submaxillary gland* is situated upon the side of the floor of the mouth below the lower jaw. Its duct is about 2 inches long and opens just in front of the root of the tongue.

Fig. 50.—The salivary glands: *a*, Sublingual gland; *b*, submaxillary gland, with its duct opening on the floor of the mouth beneath the tongue at *d*; *c*, parotid gland and its duct, which opens on the inner side of the cheek at *e* (after Yeo).

The *sublingual gland* is the smallest of the three pairs of glands, and lies just beneath the mucous membrane of the floor of the mouth. It opens into the mouth below the tongue by from 8 to 20 small ducts.

The secretion from these glands, mixed with that from the many small glands in the mucous membrane of the mouth, forms the saliva, or "spit." It is an alkaline fluid, containing as its active principle a substance called *ptyalin*, which has the property of changing insoluble starch into a very soluble sugar.

THE ESOPHAGUS.

Extending down from the lower part of the pharynx in front of the spinal column and terminating in the stomach is the *esophagus*, or gullet. It is a canal about 9 inches long, composed of a muscular coat which is lined with a mucous membrane. It serves to convey the food from the mouth to the stomach.

THE STOMACH.

The stomach is an inverted, pear-shaped, bag-like dilatation of that part of the alimentary canal lying between the esophagus and intestines. The greater portion of it lies upon the left side of the abdomen beneath the diaphragm and anterior abdominal wall. The larger dilated end, lying to the left, is called the cardiac extremity, while the smaller end, lying to the right, is called the pyloric extremity, and the portion between the two is known as the body. Where the stomach opens into the small intestine there is a muscular ring, the *pylorus*, which acts as a valve. The stomach has a capacity of from 5 to 8 pints, and, when moderately distended, its greatest diameter measures 10 to 12 inches. When empty, it lies in a collapsed condition.

Structure of the Stomach.—It is composed of 4 coats: serous, muscular, submucous, and mucous.

The *serous*, or *peritoneal coat*, is the thin glistening membrane covering the exterior of the organ.

Fig. 51.—The stomach.

The *muscular coat* is composed of 3 layers of involuntary muscular fibers arranged in different directions: longitudinally, circularly, and obliquely. By the contraction of these muscular fibers the contents of the stomach are mixed and churned up.

The *submucous coat* contains blood-vessels and nerves.

The *mucous coat* is a thick, pink mucous membrane forming the inner lining of the stomach. When the stomach is empty it is thrown into numerous folds, which disappear when the organ becomes distended.

The surface of the mucous membrane is studded by small openings, the *gastric glands*. They secrete an acid fluid, the *gastric juice*, which contains as its active principles *pepsin* and *rennin*. The former changes proteid substances into a more soluble form, while the latter has the property of coagulating milk and forming curds.

THE SMALL INTESTINE.

The small intestine is that part of the alimentary canal extending from the stomach above to the large intestine below. It is about 22 feet long, and in diameter varies from 1 to 2 inches. It is divided into duodenum, jejunum, and ileum.

The **duodenum** is bent upon itself like a letter U and is that portion of the small intestine leading from the stomach. It forms but a small part of the intestinal canal, being only 10 to 12 inches long. It is, however, much wider than the rest of the small intestine, about 2 inches in diameter, and its walls are also thicker. Opening upon the posterior wall at the middle of the duodenum is the common opening for the bile duct and pancreatic duct.

The **jejunum** is 8 to 9 feet long, has thinner walls than the duodenum, and is smaller, being about 1½ inches in diameter.

The **ileum** is 12 to 13 feet long, has thinner walls than any other part of the small intestine and also is smaller, narrowing toward its end to about 1¼ inches in diameter.

Structure of the Small Intestine.—Like the stomach it is composed of a serous, muscular, submucous, and mucous layer.

The *serous coat* invests all the intestine except part of the duodenum, and is reflected to the posterior abdominal wall, forming the mesentery, which holds the intestine in place.

The *muscular coat* is in two layers, circular and longitudinal. By the contractions of these muscular fibers, called *peristaltic contractions*, the contents of the intestine are propelled along the canal.

The *submucous* layer contains blood-vessels and nerves.

The *mucous coat*, or mucous membrane, is thick and vascular in the upper part of the intestine, but thinner below. It is thrown up into numerous folds, the *valvulæ conniventes*, and is covered by small vascular projections termed *villi*, from each of which proceeds a lymph vessel, the *lacteal*, which empties into a common duct, the *thoracic duct*.

There are three kinds of glands in the small intestine: the *glands of Lieberkühn*, found all through the mucous membrane; the *glands of Brunner*, found only in the duodenum and upper part of the ileum; and *Peyer's glands*, found in the ileum. The secretion from the intestinal glands is an alkaline, yellowish fluid, called *succus entericus*, which has the property of rendering starch and sugar more soluble.

THE LARGE INTESTINE.

The large intestine is that portion of the alimentary canal lying between the small intestine and anus. It is 5 to 6 feet long and 2½ inches in diameter at its widest point. It begins upon the right side as a dilated pouch, 2½ to 3 inches long, termed the *cecum*, from which extends a narrow, blind tube, the *vermiform appendix*. The opening for the ileum is guarded by a double valve-like fold of tissue, the *ileo-cecal* valve. From the cecum the large intestine passes up the right side of the abdomen as the *ascending colon*. Upon reaching the liver it makes a sharp turn and passes across the abdomen as the *transverse colon*. On the left side of the body it passes down as the *descending colon*, and terminates in the *rectum*, which opens externally as the *anus*.

Structure of the Large Intestine.—Like the stomach and small intestine it is composed of four coats.

The *serous*, *muscular*, and *submucous* coats are of the same structure and have much the same arrangement as the corresponding coats of the small intestine.

The *mucous coat* is rather thin, pale, and thrown into folds, but differs from that of the small intestine in having no villi.

There are only a few solitary glands in the large intestine.

THE LIVER.

The liver is a dark, reddish-brown gland occupying the right side of the abdomen and part of the left, lying below the diaphragm and above the stomach and intestines. It is the largest organ in the body, weighing 50 to 60 ounces, and measures 11 inches in its longest diameter, 8 inches antero-posteriorly, and 2½ inches vertically. Its upper surface is convex and is in contact with the diaphragm, while the lower surface is concave and supports the gall bladder.

The **gall bladder** is the pear-shaped receptacle or reservoir

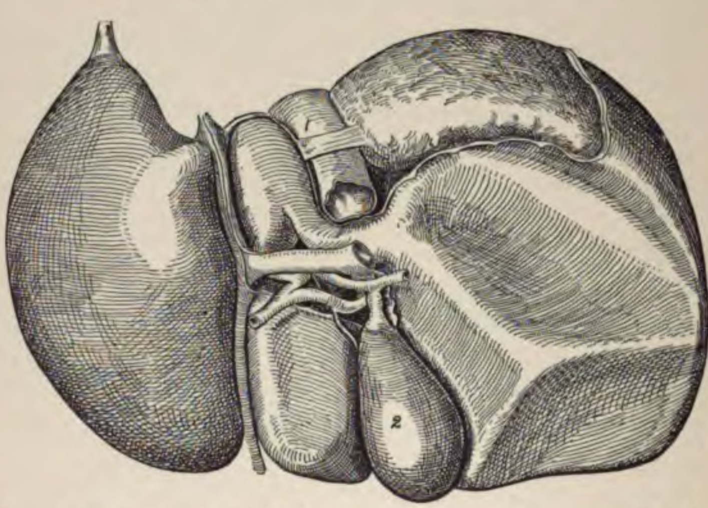

Fig. 52.—The liver, seen from below. 1, Inferior vena cava; 2, gall bladder.

for the bile, 3 to 4 inches long, with a capacity of from 8 to 12 teaspoonfuls. It has a duct leading from its smaller end which is joined by a duct from the liver, and the two form a single duct, the *common bile duct*, which empties into the duodenum.

Structure of the Liver.—The liver is composed of five lobes and is covered with peritoneum which is reflected on to the diaphragm, forming ligaments which serve to hold the organ in place. Each lobe is composed of a number of lobules, which in turn consist of a collection of liver cells arranged around a central vein, the *intralobular vein.* Thus the blood circulating through the liver is brought in contact with the liver cells.

The liver has the important function of secreting *bile*, of manufacturing a substance called *glycogen*, which is readily converted into sugar, and of excreting certain waste matter, called *urea.*

Fig. 53.—Section through liver of pig, showing chains of liver-cells. × 70 (Böhm and Davidoff).

The bile is a yellow or yellowish-brown alkaline fluid, with a very bitter taste, having the property of emulsifying fats. It is secreted continually, but is only discharged into the intestine during digestion, at other times being stored up in the gall bladder.

THE PANCREAS.

The pancreas, or sweetbread, is a narrow, elongated gland, 6 inches in length, 2 inches broad, and 1 inch thick, weighing 2 to 3 ounces. It extends transversely across the abdomen on the left side, lying behind the stomach and intestines. From its interior leads a duct which opens into the duodenum in the same opening with the common bile duct.

The pancreas secretes a slightly viscid, alkaline fluid, which has the property of converting starch into sugar, of emulsifying fats, and of rendering proteid substances soluble.

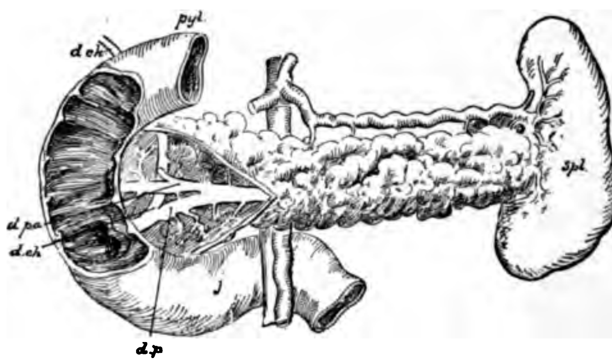

Fig. 54.—Pancreas dissected to show (*d. p.*) pancreatic duct; *d. pa.*, accessory duct; *d.ch.*, bile duct; *spl.*, spleen; *j.*, jejunum (modified after Robson and Moynihan).

FOOD AND DIET.

The human body is constantly undergoing waste, its tissues being destroyed, or burnt up, so to speak, in furnishing heat and energy. The wasting of the tissues goes on continually, even during sleep when the body is at rest, but is more marked during the active exercise of brain or muscle. To furnish the tissues with a source of heat and energy and to make good the waste that is constantly going on, certain materials, known by the name of *foodstuffs*, must be taken into the body daily in a definite amount. If this is not done, the tissues themselves are called upon to supply all the heat and energy, with the result that a rapid wasting ensues, the body loses weight, and finally a condition of starvation occurs. The foodstuffs are classified as follows:

Proteids, or nitrogenous foods, such as fatless meats and the whites of eggs, contain carbon, hydrogen, oxygen, and nitrogen. They are absolutely necessary for the maintenance of nutrition, as it is from them that new tissues are formed and old tissues repaired. In addition proteids furnish the source of some of the heat and energy supplied to the body.

Carbohydrates, such as starches, sugars, and gums, predominate in vegetable foods and contain carbon, hydrogen, and oxygen, but no nitrogen. They are destroyed in the body and liberate a certain amount of heat and energy.

Fats, such as all vegetable and animal fats, like the carbohydrates, contain carbon, hydrogen, and oxygen, but no nitrogen. They have practically the same use as the carbohydrates. The fats and carbohydrates are sometimes called the non-nitrogenous foods.

Water and Salts.—These substances are absolutely necessary for the body, yet in a free state are not considered vital foods, because nearly all foods contain water and salts in a greater or less amount.

A suitable diet, then, for an adult should consist of food composed of water, salts, proteids, carbohydrates, and fats, or, in other words, should contain the same elements of which the body is composed. Without proteids the body will waste, because there is nothing in the other foodstuffs to supply nitrogen, so necessary to the tissues. A person can exist on a proteid diet alone, but a very large quantity of proteid material would have to be consumed to obtain the necessary heat and energy, thus throwing a lot of unnecessary work upon the digestive organs. From this it is evident that a mixed diet, containing the three chief ingredients—proteids, carbohydrates, and fats—in such an amount as not to be in excess of the needs of the body, is not only the most nutritious diet, but is also most economical for the tissues.

DIGESTION.

The material taken into the body as food, while containing the necessary principles for nutrition, is often in an insoluble form and of a composition far different from the tissues it is to build up or repair. It thus becomes necessary that all foods should be digested or, in other words, changed into such form that they can be easily absorbed and at the same time furnish the necessary nourishment for the tissues.

When the food is taken into the mouth it is thoroughly ground and chopped up by the teeth. At the same time the salivary glands begin to secrete a large quantity of saliva, which moistens the mouth and food and thoroughly mixes with the latter. The food thus becomes converted into a semisolid mass and all portions of it are exposed to the action of the saliva, while the insoluble, starchy constituents commence to be converted into a more soluble sugar. The *bolus*, as the food now thoroughly masticated and mixed with saliva is called, passes back into the pharynx, but is prevented from getting into the nose by the soft palate; it is pushed farther back by the tongue, passing over the larynx, which is closed by the epiglottis; and is then grasped by the muscular walls of the pharynx and pushed on into the esophagus. This tube then begins to contract from above downward and propels the bolus along into the stomach.

As soon as the stomach receives the food, an abundant secretion of gastric juice is poured out by the gastric glands, and the organ commences to contract. The food is thus churned up and thoroughly mixed with the acid gastric juice until it resembles a thick pea-soup, and is now known as the *chyme*. The gastric juice through its acidity prevents any further digestion of the starches, which as we have seen commenced in the mouth, but it acts upon the proteids, however, changing them into more soluble substances, the *peptones*. Most of the chyme passes out into the duodenum through the pylorus, while a small part of it—the soluble sugars and peptones—is absorbed directly by the blood-vessels of the stomach wall.

As the chyme passes into the duodenum, the bile and pancreatic juice is poured out and mixes with the acid chyme, converting it into an alkaline mixture, the *chyle*. The secretions from the liver and pancreas, with those from the intestinal glands themselves, act on any proteids that remain undigested, converting them into more soluble substances. At the same time the conversion of starch into sugar, which was interrupted while the food was in the stomach, is continued. Finally, fats and oils are emulsified or broken up into minute drops, in which form they are more readily absorbed. As the chyle is forced along the intestine by its contractions, the digested proteids and carbohydrates are absorbed directly by the blood-vessels of the intestine, while the fine fat globules, not being dissolved, cannot pass directly into the blood but first enter the lacteals of the villi, then pass into the thoracic duct, and eventually enter the blood through the superior vena cava.

When the digested matter with the undigested residue reaches the large intestine it is in a fluid condition, but, during its passage through this canal, the fluids, as well as any dissolved substances which may have escaped absorption in the small intestine, are absorbed. The contents of this portion of the bowel are thus gradually converted into a solid mass, and by the time it reaches the rectum it is dark in color, has a characteristic odor, and is known as the *feces*.

To sum up the process of digestion, we may say that the carbohydrates only are digested while the food is passing to the stomach; that in the stomach proteids alone are digested and a small quantity of soluble proteids and carbohydrates are absorbed; that in the small intestine carbohydrates, proteids, and fats are all digested and absorbed; and that in the large intestine a further absorption of those substances and of the fluids occurs.

CHAPTER VII.

THE EXCRETORY SYSTEM.

Excretion is the process of removal of the waste of the tissues from the body. These waste products are carbonic acid, salts, urea, and water. They are continually poured into the blood as it circulates through the capillaries, and the blood rids itself of these products through the lungs, skin, and kidneys; these organs in turn have the function of eliminating waste products from the body.

The Lungs as Excretory Organs.—The anatomy of the lungs has already been described (page 78).

As excretory organs they remove from the body a large quantity of carbonic acid and a small quantity of water, part of the fluid exhaled probably coming from the moisture of the nostrils.

The Skin as an Excretory Organ.—For the structure of the skin see page 46.

Its secretion, the sweat or perspiration, is a colorless fluid with a salty taste and peculiar odor, in which are excreted water, certain salts, carbonic acid, and urea. The amount of carbonic acid given off by the skin is less than $\frac{1}{100}$ part of the amount given off by the lungs, and but very small quantities of urea are normally eliminated.

There is always a little perspiration being excreted, though we may not be conscious of it, the average amount in twenty-four hours being about 2 pounds (pints); it may, however, only amount to a few ounces. The perspiration may be so scant that it immediately evaporates, leaving no visible residue upon the skin; this is known as *insensible perspiration*. If, on account of an increase in the quantity of fluid perspired or on account of the temperature, the perspiration does not evaporate but remains in drops upon the skin, it is called *sensible perspiration*. Any condition causing the blood to circulate freely through the skin will cause an individual to perspire more freely. After eating, after violent exercise, or in hot weather, a large amount of perspiration is excreted. On the other hand, early in the morning and in very cold weather when the skin is less active, but little perspiration is lost. The amount excreted also depends upon the quantity of fluids a person takes.

The function of the sweat glands is to regulate the temperature of the body. Under the influence of high degrees of heat the sweat glands are stimulated. They pour out an increased amount of fluid which rapidly evaporates and thus cools off the surface of the body. For this reason a dry atmosphere of high temperature can be borne more readily than an atmosphere of even lower temperature laden with moisture. In the first instance evaporation of moisture readily occurs; in the latter case evaporation is interfered with, and the body rapidly becomes overheated.

THE KIDNEYS.

The kidneys are two bean-shaped glands lying upon the posterior abdominal wall on either side of the spinal column. They are reddish-brown in color and measure about 4 inches in length, 2 to 3 inches in width, and 1 to 1½ inches in thickness. Leading from each kidney is its excretory duct, the *ureter*. This is a tube about 18 inches long and the size of a goose-quill which passes down along the posterior abdominal wall into the pelvis and terminates in a musculo-membranous sac or reservoir, the *bladder*.

Structure of the Kidney.—The kidney consists of an outer *cortical part* and an inner portion, the *medulla*. Its substance is composed of a number of Malpighian bodies and uriniferous tubules.

The **Malpighian bodies** are situated in the cortex of the kidney near the surface, and consist of a tuft of blood-vessels, the *glomerulus*, and an expansion of the uriniferous tubule which forms a capsule, or covering, about the glomerulus. The glomerulus is composed of a small afferent artery, which breaks into a number of twisted capillaries, and these in turn unite to form a single efferent vessel which enters capillaries surrounding the uriniferous tubules.

The **uriniferous tubules,** after leaving the Malpighian body, coil around and change their direction a number of times, finally emptying into the ureter.

By this arrangement of the blood-vessels the arterial blood is brought directly to the glomerulus, through which it passes and then supplies the uriniferous tubules. It is while circula-

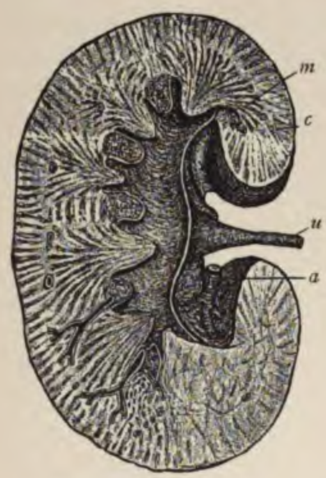

Fig. 55.—A longitudinal section of the kidney. *a*, Renal artery; *c*, cortex; *m*, medulla; *u*, ureter (Leroy).

Fig. 56.—A Malpighian body or corpuscle. *a*, Afferent artery; *e*, efferent vessel; *c*, capillaries; *k*, commencement of uriniferous tubule; *h*, uriniferous tubule (Leidy).

ting through the glomerulus that the blood gets rid of some of its fluid constituents by a process of filtration, while the solid waste products are excreted by the uriniferous tubules. The carbonic acid, salts, urea, and water finally pass into the tubules and are discharged from the kidneys into the ureters in the form of urine.

The urine is a pale, amber, yellowish liquid with an acid reaction, having a salty taste, and containing about $\frac{1}{20}$ of its weight of solids. It is excreted continuously by the kidneys, and trickles drop by drop into the bladder until a sufficient quantity has accumulated to distend that organ and cause an uneasy sensation to be felt by the individual, when it is discharged by contraction of the bladder. In a normal person about 50 ounces of urine are excreted daily, but the amount varies in different individuals, depending upon the quantity of fluid swallowed, upon the food, upon the external temperature, and upon the amount one perspires. As eliminators of water, the kidneys may be considered as accessories of the skin, the amount of water they excrete depending upon that excreted by the skin,—that is, the less the amount lost through the skin, the more will be excreted by the kidneys. The amount of solids excreted, however, has little to do with the perspiration, being dependent entirely upon the waste going on in the body.

CHAPTER VIII.

THE NERVOUS SYSTEM.

The elements composing the nervous system are nerves and nerve centers.

The **nerves** are simply round cords consisting of nerve fibers which form connections between the centers and distant points. They have the function of conveying and transmitting nervous impulses and are of two kinds, according to the function they perform. Those that convey impressions from their peripheral terminations to their centers are spoken of as *sensory* nerves. Those that transmit impulses from these centers to the parts with which they are connected are known as *motor* nerves.

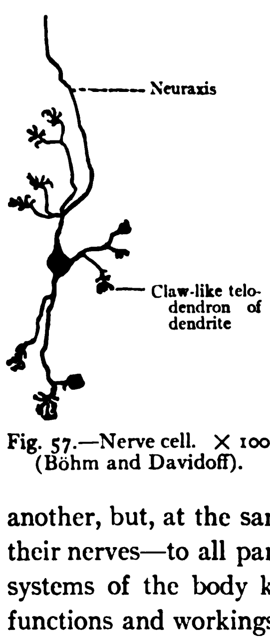

Fig. 57.—Nerve cell. × 100 (Böhm and Davidoff).

The **nerve centers** are composed of several nerve cells, or a large collection of cells, and are distributed through the brain, spinal cord, and ganglia. Their function is to recognize and dispose of impressions received through the sensory nerves.

The whole nervous system consists of a *continuous* chain of nerve cells which are in close relation with one another, but, at the same time, extend by means of branches—their nerves—to all parts of the body. In this way the different systems of the body keep in touch with one another, and the functions and workings of the organs comprising these systems are controlled and regulated.

For convenience of description the nervous system is usually divided into the *cerebrospinal* and the *sympathetic system.* The former is composed of large nerve centers, the brain and spinal cord (cerebrospinal axis), and nerves given off from these centers; while the sympathetic system is composed of a series of small centers termed ***ganglia***, and nerves connected with these ganglia.

Fig. 58.—General view of the cerebrospinal nervous system (after Bourgery; Schwalbe).

THE CEREBROSPINAL SYSTEM.

THE BRAIN.

The brain is that part of the cerebrospinal axis inclosed within the skull. It weighs about 50 ounces, being nearly as heavy as the liver, but much smaller in size. As a rule the size of the brain is in proportion to the intellectual capacity of the individual. It is composed of a gray and a white matter, the former consisting chiefly of nerve cells, while the latter consists of nerve fibers. Its surface is divided by a great many small fissures, lying between which are masses of gray matter, the *convolutions*. The brain is separated from the bony walls of the cranium by three membranes: an outer, of tough fibrous tissue, closely adherent to the interior of the skull, the *dura mater;* a middle, a thin, delicate membrane, called the *arachnoid;* and an inner, a vascular covering which closely envelops the surface of the brain, the *pia mater*. Between the arachnoid and pia mater is a space filled with fluid, the *cerebrospinal fluid*. The brain consists of four main portions: the *cerebrum*, *cerebellum*, *pons varolii*, and *medulla oblongata*.

The **cerebrum**, occupying the uppermost portion of the cranium, comprises the greater part of the brain. It is divided from before backward into two halves, the ***hemispheres.*** Externally, it consists of gray matter thrown into many convolutions which increase its surface area without taking up additional space. Interiorly, it is composed of white matter.

The cerebrum is the seat of the intellect, volition, ideas, emotions, and motor actions.

The **cerebellum,** or small brain, is situated behind and below the cerebrum. It consists of two hemispheres, the gray

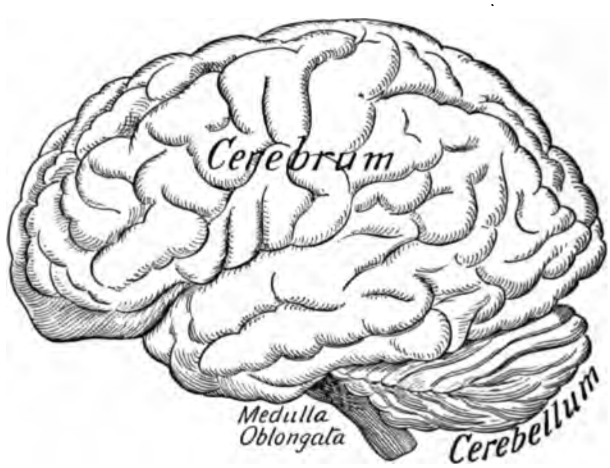

Fig. 59.—The brain.

and white matter having the same arrangement as in the cerebrum. Its surface, however, is not convoluted, but is marked by numerous furrows.

The cerebellum is not concerned with the intellectual functions but regulates and coördinates the contractions of muscles.

The **pons varolii,** or bridge of Varolius, is a thick band of nerve tissue, consisting chiefly of white matter, which passes around in front of the medulla and connects the two hemispheres of the cerebellum, and also forms a path of communication between the cerebrum and medulla oblongata.

The pons serves as a means of communication between the higher parts of the brain and the spinal cord.

The **medulla oblongata** is the lowermost division of the brain. Its upper surface is connected with the pons varolii, while its lower surface passes insensibly into the spinal cord.

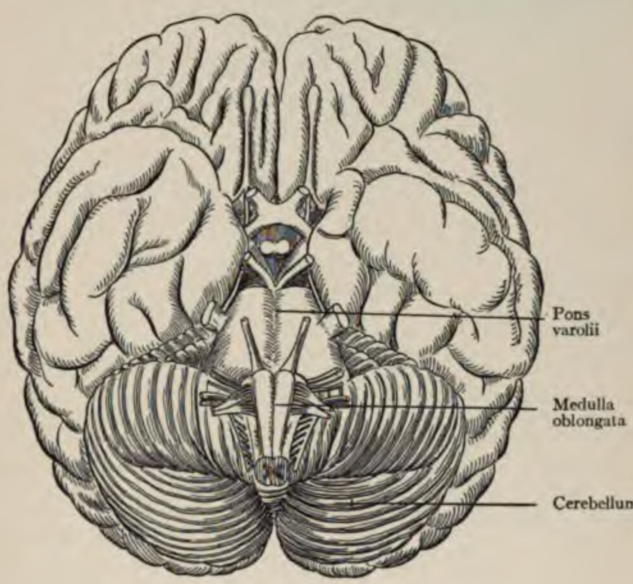

Fig. 60.—Base of the brain.

It is composed of white and gray matter, the former situated externally and the latter internally.

The medulla transmits all of the nerves passing between the brain and spinal cord. It is also the seat of certain involuntary acts, as swallowing, vomiting, and breathing, and has centers which control the blood-vessels and heart.

THE SPINAL CORD.

The spinal cord is the terminal portion of the cerebrospinal axis occupying the upper two-thirds of the spinal column. It is 17 to 18 inches long and nearly cylindrical in form. Above it is continuous with the medulla; below it terminates opposite the first lumbar vertebra in the form of a cone, from which extends a fine prolongation, the *filium terminale*. It is composed of white matter externally, and gray matter internally. The white matter consists of motor and sensory nerves, the former running in the anterior part of the cord, while the latter occupy the posterior. Nearly all the nerves supplying the voluntary muscles below the head arise from the cord, while the sensory nerves from these same regions enter it. Surrounding the cord are continuations of the same three membranes which envelop the brain.

The cord serves to convey impressions received through its sensory nerves to the brain and, in response to these impressions, transmits from the brain motor impulses. It also possesses the power of originating motor impulses in response to certain stimuli, and so can, at times, act as a nerve center itself, independently of the brain. For example, if the hand be placed in the fire a sensation of pain is produced, and this sensation is conveyed by the sensory nerves supplying the part to the spinal cord, in response to which the cord sends out a motor impulse to the muscles of the arm, with the result that they contract and the hand is quickly withdrawn. Now, this impulse sent out from the cord was produced entirely independent of any action of the brain, and did not originate from the will or volition, but in response to an outside stimulus. This power possessed by the cord is known as that of *reflex action*.

CEREBROSPINAL NERVES.

The cerebrospinal nerves are those which arise from some portion of the brain or spinal cord. They are divided into the cranial and the spinal nerves. Some are sensory; some are motor; and others are composed of both sensory and motor fibers, termed *mixed* nerves.

The Cranial Nerves.—These are twelve pairs of nerves which arise from centers in the brain and pass out of the skull through openings in its base.

The *first pair*, the *olfactory*, are the nerves for the special *sense of smell*, and supply the interior of the nose.

The *second pair*, the *optic*, are the nerves for the special *sense of sight*, and are distributed to the eyes.

The *third pair*, the *oculo-motor*, and the *fourth pair*, the *trochlear*, are both *motor* nerves supplying most of the muscles of the eyes.

The *fifth pair*, the *trifacial*, are *mixed* nerves, the sensory fibers supplying the skin of the face, the teeth, the tongue, and the mucous membrane of the mouth, nose, and eyes, the motor fibers supplying the muscles of the jaws.

The *sixth pair*, the *abducent*, are *motor* nerves for the external muscles of the eyes.

The *seventh pair*, the *facial*, are *motor* nerves for the muscles of the face.

The *eighth pair*, the *auditory*, are the nerves for the special *sense of hearing*.

The *ninth pair*, the *glosso-pharyngeal*, are *mixed* nerves. They are the nerves for the special *sense of taste* and distribute both sensory and motor fibers to the pharynx.

The *tenth pair*, the *pneumogastric*, are *mixed* nerves, supplying motor and sensory fibers to the pharynx, larynx, trachea, lungs, heart, esophagus, stomach, intestines, and liver.

The *eleventh pair*, the *spinal accessory*, are *motor* nerves, supplying through the spinal portion certain muscles of the back and neck. The other fibers unite with the pneumogastric.

The *twelfth pair*, the *hypoglossal*, are the *motor* nerves for the muscles of the tongue.

The Spinal Nerves.—There are 31 pairs of nerves arising from the spinal cord called the *spinal nerves*. They take origin from each side of the cord by two roots. The anterior roots contain motor fibers from the anterior part of the cord, the posterior roots spring from the posterior part of the cord, and contain sensory fibers. The two roots unite and pass out of the spinal column as mixed nerves. They then divide into anterior branches which supply the anterior portions of the trunk and all the extremities, and posterior branches which supply the posterior portions of the trunk. Both branches are composed of sensory and motor fibers.

Fig. 61.—Diagrammatic view of the sympathetic cord of the right side, showing its connections with the principal cerebrospinal nerves and the main preaortic plexuses. (Reduced from Quain's Anatomy.)

THE SYMPATHETIC SYSTEM.

The sympathetic system consists of two chains of small nerve centers, the *sympathetic ganglia,* situated on each side of the spinal column, communicating with each other and with the cerebrospinal nerves by nerve fibers and distributing branches to the blood-vessels and internal organs, as the heart, lungs, alimentary tract, secreting glands, etc. This system of nerves presides over and controls the vital functions and, while connected with the cerebrospinal system, yet is not under the control of the will and acts independently, so that when the brain ceases to work, as in sleep, unconsciousness, or paralysis, the vital organs can continue their work unaffected.

The sympathetic system has the same power of receiving and transmitting impulses and of participating in reflex actions as has the cerebrospinal system. Blushing may be taken as an example of the latter. Some mental emotion—it may be caused by pleasure, anger, pain, or shame—affects the sympathetic nerves which control the blood-vessels of the face, with the result that they enlarge, more blood circulates through the face, and the skin becomes hot and red. Upon some people fright may have this same effect and upon others just the opposite effect, causing the blood-vessels of the face to contract, or grow small, with the result that the skin becomes pale and white. As still another example of this reflex action of the sympathetic system, the presence of food in the stomach will cause impressions to be felt by the ganglia which preside over that organ and result in contractions in the stomach wall and a profuse secretion from the digestive glands.

That the sympathetic system is in close relation with the brain and spinal cord is well illustrated by the convulsions frequently produced in young children from slight digestive disturbances. The convulsions are often caused by an irritation from particles of undigested material remaining in the intestines. The irritating effect of this material is first felt by the sympathetic nerves supplying these organs, impulses are then transmitted to the cerebrospinal system and brain, and as a result convulsions occur.

PART II.

BANDAGES, DRESSINGS, PRACTICAL REMEDIES, ETC.

CHAPTER IX.

BANDAGES AND SLINGS.

BANDAGING.

The two types of bandage in general use are the roller bandage and the handkerchief, or triangular, bandage. Of the two the former is probably more universally used, as it can be quickly and easily applied, and, when properly adjusted, it certainly forms a very neat and well-fitting dressing. The handkerchief bandage, on the other hand, is more applicable to emergency cases and is frequently used upon the field for temporary dressings or for making slings.

Bandages have many uses, but they are commonly employed for the purpose of retaining dressings and splints, for controlling hemorrhage, and as a means of furnishing protection or support to different portions of the body.

Gauze and unbleached muslin are the materials from which most bandages are made, but for special purposes flannel, crinoline, silk, elastic webbing, and rubber may be utilized. Whatever the material used it should be firm of texture and free from any wrinkles or creases. The material should never be pieced, as such bandages are not only rough and unsightly in appearance, but they may do actual harm by exerting undue pressure upon the parts beneath.

THE ROLLER BANDAGE.

A roller bandage consists of a strip of muslin or other material rolled in the form of a cylinder, so as to be in a convenient shape for application. It may be described as consisting of an initial end, a body, and a terminal end. When the bandage is rolled from one extremity only it is known as a single roller. When the bandage is rolled from both extremities toward the center, it is known as a double roller, forming a bandage consisting of two cylinders.

Bandages vary in length from three to twelve yards, and in width from one to six inches. For the fingers and toes they

Fig. 62.—Method of rolling a bandage.

should be about one inch wide and three yards long; for the extremities, two to two and one-half inches wide and about six yards long; and for the trunk, a bandage should be four to six inches wide and twelve yards long.

To Roll the Bandage.—The material is torn into the required width, the selvedge having been previously removed. The strip is then rolled by first folding one end upon itself several times until a small cone or cylinder is formed. When this cylinder is of sufficient size to allow of its being grasped at each end between the thumb and forefinger without collapsing, it is held by the left hand lightly in this position while the right hand is used as a guide, the cylinder being made to revolve in the left hand, as shown in the accompanying illustration. This process is continued until the bandage has been entirely rolled. Care must be observed in rolling to avoid wrinkling the material, and to roll it evenly and firmly. When a large number of bandages are to be rolled much time may be saved by using a machine especially adapted for this purpose. In this way a whole bolt of muslin may be rolled at once and afterward cut with a knife into the required widths.

The Application of the Bandage.—To properly apply a bandage, first face the patient, then, grasping the body of the bandage in the right hand with its initial or free end in the left hand, place the outer surface of the free end upon the part to be bandaged and hold it in place with the fingers of the left hand, while the right hand carries the roll around the limb, finally coming back to the starting-point. The left hand may then be removed and can be used alternately with the right hand in carrying the roll around the limb. This first turn is repeated several times, and is termed "fixing the bandage."

To Secure the Bandage.—Having completed the bandage, its extremity must be made secure. This can be done by means of pins, sewing, tying, or adhesive straps.

If a bandage is pinned, be careful to insert the pins downward and bury the points in the substance of the bandage. This prevents the points of the pins from catching in the clothing or otherwise doing harm.

While pinning and sewing are the safer methods, as a knot may cause discomfort from pressure upon the tissues, there are many occasions when pins and needles are not available, and in such cases it is necessary to tie the bandage. This may be done by tearing the terminal end for several inches into two tails. These two tails are tied once to prevent any further tearing, and are then carried around the limb from opposite directions, and, when they meet, are tied. A quicker way, however, is to leave about eighteen inches of the bandage free. This is grasped in one hand at about two-thirds the distance from its end, while the other hand carries the remaining portion around the limb in the opposite direction. This leaves two ends to tie, one consisting of the double strip of muslin, and the other of the single end.

Adhesive plaster may be employed to secure the bandage by simply using a small strip to fasten the loose end to the body of the bandage.

Hints on Applying Bandages.—While the art of applying bandages can only be acquired by diligent practice, still there are a few rules and some few cautions that should be observed.

To begin with, always apply the bandage while the limb is in the position it is to remain in after the bandage is on. For example, a spica bandage should not be applied to the shoulder when the arm is at right angles to the body; later, when the arm is allowed to hang by the side, the change of position is sure to tighten the bandage and make it exceedingly uncomfortable for the patient.

When a bandage is applied to a limb simply for support, it should, if possible, be begun at the extremity of the part and be carried upward toward the body; otherwise, the part below the bandage is apt to swell and the bandage then acts as a constricting band, and strangulation of the part may follow. As a general rule it is wise to leave the fingers and toes exposed, as they furnish an excellent indication of the condition of the circulation in the limb and show whether a bandage is applied with too much tension. Should the part below the bandage become cold and blue after its application the *bandage should be immediately removed*, as this is an evidence of its being on too tight.

The beginner will find it a very difficult matter to determine just how much tension to use in applying the bandage. Of course much depends upon one's experience and skill in bandaging and upon the object for which in a given case the bandage is employed. Still, there are a few observations which if kept in mind may be helpful. It should be remembered that hard, infiltrated tissues are capable of standing a considerable amount of tension. The same is true of boggy, edematous tissues. But inflamed tissues and the soft, flabby tissues of children, can bear but little pressure. Bandages applied over splints can be put on with considerable tension, as most of the force is expended upon the splints, and the whole circumference of the limb is not subjected to pressure. Where there are heavy, yielding dressings more tension will be necessary to afford the same support than if there were none present. Wet bandages must be used with caution, as they are liable to shrink upon becoming dry. For this reason the plaster bandage is simply *laid* on, no force being used, the pressure, if any, being supplied by the bandage beneath the plaster. It should be kept in mind that the greater the circumference of the part to be bandaged the more tension is necessary. Thus, in bandaging a limb, each succeeding turn as it ascends should be applied with a *very little* more tension in order to get the same degree of support. It should also be remembered that each additional turn of a bandage upon the same region causes nearly double the amount of pressure, hence the turns should be uniform in number over the whole part, overlapping equally, and should be applied evenly and with the same amount of firmness.

Forms of Roller Bandages.—Roller bandages may be classified as follows: Circular, oblique, spiral, spiral reversed, figure-of-eight, spica, and the recurrent bandage.

The Circular Bandage consists of several repeated turns which exactly overlie each other. It is used to fix the initial end of a bandage, and also to retain dressings and compresses.

The Spiral Bandage.—In a spiral bandage each turn about the limb ascends higher and overlaps one-half to two-thirds the preceding turn with its lower edge. This bandage is only applicable to a part of uniform circumference. If applied to a conical part, the bandage will fit tightly at one edge and lie loosely at the other, thus failing to exert uniform compres-

Fig. 63.—The spiral bandage.

sion, besides presenting an unsightly appearance and being easily displaced.

Fig. 64.—The oblique bandage.

The Oblique Bandage is applied in the same way as a spiral, only the turns are separated from each other by a considerable space. It is used to retain splints and to hold dressings lightly in place.

The Spiral Reversed Bandage consists of an ordinary spiral bandage with reverses. It is applied as a spiral until the turns commence to lie loosely. A reverse is then made by placing the fingers of one hand upon the free edge of the bandage at the point selected for making the reverse, while the hand holding the roll is pronated. The result is that the turn now pursues a different course. If it was previously going up the limb, after the reverse it goes down. The roll is carried on around the limb, and, on reaching the opposite side, firm traction is made with the result that the turn will apply itself smoothly to the part. The reverses should all be made in the same line, and care must be taken that they do not fall over bony prominences. The spiral reversed bandage was originated as a substitute for a spiral bandage which would snugly fit a conical part. It is used as a means of support and to retain dressings and splints.

The Figure-of-eight Bandage consists of a series of oblique turns which cross in the form of a figure-of-eight. Each turn overlaps two-thirds of the preceding turn, alternately ascending

Fig. 65.—Method of making a reverse.

and descending (Fig. 66). It is used especially about the knee- and elbow-joints to furnish support and retain dressings.

The Spica Bandage is used about the groin, shoulder, foot, and hand. Applied to the groin or shoulder, the bandage is first made secure by several circular turns about the limb. The roll is then carried obliquely up the limb and around the trunk, and, on coming down the limb upon the opposite side, it intersects the first turn forming an angle or spica. Each turn follows the preceding turn, overlapping two-thirds of it. The spica is spoken of as ascending or descending, according to whether the turns overlap from below upward or from above downward.

Fig. 66.—Application of a figure-of-eight bandage.

The Recurrent Bandage is used to retain dressings upon the

Fig. 67.—Application of a spica bandage.

head or upon the stump of a limb. The part is covered by turns which recur successively to the point of starting, and each recurring turn overlaps two-thirds of the preceding turn. The ends of the turns are covered and held securely in position by a circular turn.

Fig. 68.—The application of a recurrent bandage.

BANDAGES FOR THE HEAD.

The Recurrent Bandage of the Head.—A roller two to two and a half inches wide and about seven yards long will be required.

The initial end is placed upon the forehead, and is held in place by the left hand while the right hand carries the bandage around the head and back to the starting-point. This circular turn is repeated twice. On reaching the back of the head the third time, the thumb of the left hand is placed upon the bandage, and at this point a right-angled reverse is made. The roll is carried across the median line of the head from behind to the forehead. An assistant holds the bandage at this point, while the turn is

Fig. 69.—Recurrent bandage of the head.

made to recur to the back of the head covering two-thirds of the first turn and converging to the starting-point. The roll is again carried to the forehead, overlapping two-thirds of the first turn upon the opposite side. These turns are repeated until the whole head is covered. Another right-angled reverse is then made, and several circular turns are carried around the head to fix the ends of the reverses. The bandage may be secured by pinning or tying. Pins must also be inserted in front and behind to hold the reverses in place.

Fig. 70.—Figure-of-eight bandage of one eye.

Uses.—To retain dressings and compresses to the head.

Fig. 71.—Figure-of-eight bandage of both eyes.

Figure-of-Eight Bandage of the Eye.—A roll two to two and a half inches wide and five yards long is required.

If the right eye is injured, bandage from left to right; if the left eye is to be covered, bandage from right to left. After fixing the bandage by two circular turns around the head, place the thumb of the left hand upon the bandage behind and make a right-angled reverse, carrying the roll down below the ear of the injured side and up across the eye to be covered. Continue up over the parietal bone of the opposite side and back to the point of starting. Repeat this turn several times, and finally make several circular turns about the head. To prevent slipping, the bandage should be pinned at the points of intersection.

Fig. 72.—Barton's bandage.

Uses.—To retain dressings and compresses to the eye.

Figure-of-Eight Bandage of Both Eyes.—Use a roll two to two and a half inches wide and seven yards long.

Fix the bandage by two circular turns about the head, passing from right to left. Make a reverse and carry the roll down over the left eye, across the cheek, under the left ear, around the neck, and up over the right eye to the starting-point. Make another reverse and continue around the head, and then repeat the first turn, overlapping the previous turn. The bandage is completed by two circular turns around the forehead.

Fig. 73.—Gibson's bandage.

Uses.—To retain dressings and compresses to both eyes.

Barton's Bandage.—Use a roll two to two and a half inches wide and five yards long.

The initial end is placed behind the ear of the sound side and is held by the thumb of the left hand, while the roll is carried down under the occiput, up behind the ear of the injured side, and over the skull. From here it passes down the sound side of the face, in front of the ear, under the chin, and backward up the injured side of the face to the vertex, where it crosses the first turn. It is then continued down behind the ear of the sound side, around the neck, over the chin, and back to the occiput. Repeat these turns twice and secure the bandage by pinning or sewing.

Uses.—To hold the fragments of a fractured jaw in place and to retain dressings upon the chin and back of the neck.

Gibson's Bandage.—A roll two to two and a half inches wide and five yards long will be required.

Gibson's bandage consists of three series of circular turns. Start the roll down the sound side of the face and make three circular vertical turns, passing in front of the ears, around the face, under the chin, and up over the vertex. With the thumb of the left hand over one temple hold the bandage in position and make a right-angled reverse. The bandage then passes downward below the occiput, across the forehead, and back to the point of starting. This circular turn around the head is repeated three times. On reaching the occiput the third time, the bandage is carried forward beneath the ears, around the chin, and back to the occiput. Repeat this turn three times and, on reaching the occiput the last time, make a right-angled reverse and carry the roll up over the head to the forehead. Secure the bandage by pinning all the points of intersection.

Uses.—As a dressing for fractured jaw.

The Knotted Bandage.—A double roller two and one-half inches wide and seven yards long will be required.

Place the portion of bandage lying between the two rolls upon the temple of the injured side. Then carry the two rolls from opposite directions around the head and back to the starting-point. Where they meet, a half turn is taken, and the rollers are then carried from opposite directions around the face. On coming back to the starting-point, another half turn is taken, and the rolls again pass around the head. Alternate head and face turns are taken until several knots are formed upon the side of the head; then secure the bandage.

Uses.—The knotted bandage is used to exert pressure upon the temporal vessels.

Fig. 74.—The application of the knotted bandage.

BANDAGES FOR THE UPPER EXTREMITY.

Ascending Spica of the Shoulder.—Use a roll two and a half to three inches wide and seven yards long.

Fix the bandage by several circular turns about the middle of the injured arm, then carry the bandage across the chest (if the right side is injured), and across the back (if the left side is injured); continue the turn around the body, under the arm-pit of the uninjured side and back to the injured arm. Then pass around the arm, forming a spica with the first turn. Repeat the turns until the arm and shoulder are covered. Each turn about the shoulder should overlap two-thirds of the previous

Fig. 75.—Spica of the shoulder.

Fig. 76.—Figure-of-eight of neck and shoulder.

turn from below upward, forming an ascending spica. As the turns approach the uninjured side, they should converge toward the armpit.

Uses.—For fractures and dislocations of the clavicle and injuries to the humerus.

Figure-of-Eight Bandage of Neck and Shoulder.—Use a roll two and a half inches wide and five yards long.

After fixing the bandage by several circular turns about the neck, carry the roll from behind up over the base of the neck, down in front of the injured shoulder, and under the armpit. It then passes from behind, up over the summit of the shoulder,

Fig. 77.—Velpeau bandage.

in front of the neck, and back to the point of starting. Repeat this turn, each time overlapping from below upward (Fig. 76).

Uses.—To retain dressings upon the neck and shoulder or in the armpit.

The Velpeau Bandage.—Two bandages, each two and a half inches wide and seven yards long, will be required.

To apply the bandage, first place the hand of the injured side upon the sound shoulder, some cotton being interposed between it and the skin. The initial end of the bandage is placed upon the scapula of the uninjured side, while the roll is carried up over the injured shoulder, and down in front of the arm half way to the elbow. From this point the roll gradually passes to the outer aspect of the arm. It is then brought forward, passing in turn below the elbow, across the front of the chest, up under the armpit of the sound side, and back to the point of starting. The next turn is an exact repetition of this and overlies it. On reaching the armpit the second time, the bandage continues directly across the back, taking in the elbow of the injured side. It then passes under the armpit and returns to the original starting-point over the uninjured scapula. A turn is now made up over the shoulder which overlaps two-thirds of the first shoulder turn. This is followed by a body turn which overlaps one-half of the first body turn. Shoulder and body turns alternate until the shoulder turns reach and support the elbow and the body turns confine the wrist, the hand being left free. Secure the bandage and pin all points of intersection.

Uses.—It is used extensively in fractures and dislocations of the clavicle and in injuries to the humerus.

Desault's Bandage.—It is a complicated dressing and requires for its application three separate rollers, each about two and a half inches wide and seven yards long, a wedge-shaped pad to fit in the armpit, and a sling for the hand.

Fig. 78.—Desault's bandage, first roller.

Application of the first roller.—A triangular pad is first placed in the armpit of the injured side with its base directed upward. The initial end of the bandage is placed upon this pad, and the roll is carried around the chest, making four spiral turns. Several figure-of-eight turns are then made between the uninjured shoulder and the pad in the armpit. This roll is used simply as a means of holding the pad firmly in the armpit.

Fig. 79.—Desault's bandage, second roller.

The same result may be obtained by using adhesive strips which pass between the chest and the back, including the pad.

Application of the second roller.—It consists of numerous spiral turns passing around the chest and including the arm of the injured side. Its object is to throw the point of the shoulder outward, using the arm as a lever and the pad as a fulcrum. Thus the turns are begun above, and, as they descend, each turn is applied with more tension than the previous one.

Application of the third roller.—Place the initial extremity of the bandage under the armpit of the sound side and carry the roller up across the chest, over the injured shoulder, and down behind the arm of the same side until the elbow is reached. Now bring the bandage forward under the forearm and across the chest to the armpit of the sound side. From this point the bandage passes up across the back to the injured shoulder and down in front of the arm, passing

Fig. 80.—Desault's bandage, third roller.

from before backward under the forearm, where it intersects the previous turn. It is then carried up across the back to the uninjured armpit again. Repeat these turns three times, and the bandage is complete. If properly applied this roller forces the shoulder upward and backward. A sling should be applied to support the forearm and hand, and all points of intersection should be pinned.

Fig. 81.—Figure-of-eight bandage of the elbow.

Uses.—Desault's bandage is especially useful in fracture of the clavicle. It may also be applied as a dressing for dislocations and injuries to the humerus.

Figure-of-Eight Bandage of the Elbow.—Use a roll two and a half inches wide and two yards long.

Fix the bandage two or three inches below the elbow-joint by several circular turns about the forearm. Then carry the roller obliquely across the front of the joint and up the arm as high as it is intended to carry the bandage. Make a circular turn here and descend across the joint to the point of starting, intersecting the first turn. Repeat these turns, overlapping two-thirds of the preceding turn each time, until only the point of the elbow remains uncovered. This may be covered in by a circular turn. The bandage should be securêd by pinning or tying.

Uses.—To retain dressings and afford support to the elbow.

Spiral Reversed Bandage of the Upper Extremity.—A roller two and a half inches wide and seven yards long will be required.

After fixing the bandage about the wrist, carry the roll across the back of the hand and around the palm, encircling the fingers. Continue to cover in the hand, using figure-of-eight turns between it and the wrist, each turn overlapping two-thirds of the preceding one. Then ascend the forearm with spiral turns until its increasing circumference causes them to fit loosely, when spiral reversed turns should be substituted. The elbow may be covered with spiral turns or by a figure-of-eight, and the rest of the arm by spiral reversed turns.

Fig. 82.—Spiral reversed bandage of the upper extremity.

Uses.—To retain dressings and furnish support for the upper extremity.

Spica of the Thumb.—Use a roller one inch wide and three yards long.

First fix the bandage at the wrist. After carrying the roll to the end of the thumb, make a circular turn at that point. The thumb may then be covered by a series of figure-of-eight turns which pass between it and the wrist, each turn overlapping two-thirds of the preceding turn.

Uses.—To retain dressings and afford support to the thumb.

Gauntlet Bandage, or **Spiral of the Fingers.**—Use a roll one inch wide and five yards long.

Fix the bandage by circular turns around the wrist and cover in the thumb with a spica or spiral turn. Return to the wrist, make another circular turn, and cover in the next finger with a spiral turn. Each finger in turn is covered in this manner.

Fig. 83. —Spica of the thumb.

Uses.—To retain dressings upon the fingers.

The Demi-gauntlet Bandage.—Use a roller one inch wide and three yards long.

After fixing the bandage about the wrist, carry the roll across the back of the hand to the thumb, which is encircled by one turn. The bandage is then carried across the back of the hand to the wrist, when another circular turn is made. Continue as above with each finger, and secure the bandage by pinning or tying at the wrist. The bandage must be applied loosely or it will become too tight upon closing the fingers.

Uses.—To retain dressings lightly upon the dorsum of the hand.

Fig. 84.—The gauntlet bandage.

BANDAGES OF THE TRUNK.

The Spiral Bandage of the Chest.—Use a roller three to four inches wide and seven yards long.

Fix the bandage by several circular turns about the waist. Then proceed to cover in the chest as far as the armpits with spiral turns which overlap one-half from below upward.

Uses.—As a dressing for fractured ribs and to retain dressings upon the chest.

Posterior Figure-of-Eight Bandage of the Chest.—Use a roll two and a half inches wide and seven yards long.

Fig. 85.—The demi-gauntlet bandage.

Fix the bandage by several circular turns about the left arm and carry the roller up over the left shoulder, and across the back to the right armpit. From here the bandage passes up over the right shoulder, down across the back to the left armpit, and then back to the left shoulder. Repeat this turn, each time overlapping two-thirds of the previous turn (Fig. 86). If desired, the bandage may be started upon the left shoulder without securing it to the left arm.

Uses.—To draw the shoulders backward and to retain dressings upon the back of the shoulders.

Single Spica of the Breast.—Use a roll two and a half inches wide and seven yards long.

Place the initial end of the bandage upon the scapula of the affected side and carry the roll up across the back, over the shoulder of the sound side, across the chest, and under the affected breast to the point of starting. Repeat this turn once to fix the bandage, and then make a circular turn about the

Fig. 86.—Posterior figure-of-eight of chest.

chest, taking in the lower portion of the affected breast, but passing beneath the sound breast. Repeat the circular and shoulder turns, overlapping two-thirds of the previous turn each time until the breast is completely covered.

Uses.—To retain dressings and to afford support to the breast.

Double Spica of the Breast.—Use a roll two and a half inches wide and ten yards long.

Start the bandage upon the right scapula and carry it over the opposite shoulder and across the chest, passing under the right breast. Continue around the chest until the left breast is reached. Here the roll passes obliquely up under it, across the chest, over the right shoulder and backward to the starting-point. Now make a circular turn about the chest, taking in the lower border of both breasts. Alternate these turns, overlapping two-thirds each time until the breasts are fully covered. Secure points of intersection by pins.

Fig. 87.—Spica of the breast (Keen and White).

Uses.—To retain dressings and to support the breasts.

BANDAGES OF THE LOWER EXTREMITY.

Ascending Spica of the Thigh.—Use a roll three inches wide and seven yards long. To apply properly, a block of wood or a cushion to elevate the hips will be required.

Fig. 88.—Spica of the thigh.

Fix the initial extremity of the bandage about the thigh of the affected side, and carry the roll from the outer side of the thigh inward across the groin and obliquely over the pubes to above the crest of the ilium on the opposite side. Pass on around the back, down over the opposite ilium, across the groin to the inner side of the thigh, here intersecting the first turn. Encircle the thigh and repeat the turn. Each turn ascends and overlaps the previous turn two-thirds, forming a spica of the groin. The turns should all converge as they pass around the crest of the ilium. Pin the points of intersection.

Uses.—To retain dressings upon the groin and as a means of support.

Double Spica of the Thigh.—Use a roller three inches wide and ten yards long.

Fix the bandage about one thigh and carry the roll as for a single spica across the pubes and around the body. Then pass across the abdomen and obliquely down the opposite groin to the outer side of this thigh. Encircle the thigh and carry the roll up across the groin from within outward, intersecting the first turn. Then pass to the crest of the ilium, around the back, and obliquely downward across the groin to the point of starting. Repeat the turns, overlapping two-thirds ascending.

Uses.—To retain dressing upon both groins.

Figure-of-Eight Bandage of the Knee.—Use a roller two and a half inches wide and two yards long.

Fix the bandage about the leg two or three inches below the knee-joint and carry the roll obliquely upward across the back of the knee to the highest point above the knee to which it is desired to carry the bandage. Make a circular turn here and carry the bandage obliquely across the back of the knee, intersecting the first turn. Repeat these turns, overlapping two-thirds ascending and descending, and cover the patella with a circular turn.

Uses.—To retain dressing and furnish support to the knee-joint.

Spica Bandage of the Foot.—Use a roller two and a half inches wide and three yards long.

Fix the bandage about the ankle and carry the roll obliquely across the dorsum of the foot, making a circular turn around the proximal end of the toes. Follow this by a turn which passes to the heel and back across the dorsum of the foot, intersecting the first turn and forming a spica over the dorsum of the foot. Repeat the turns, overlapping two-thirds ascending and descending, until the foot is covered in.

Uses.—To retain dressings and furnish support for the foot.

Complete Bandage of the Foot.—Use a roller two and a half inches wide and three yards long.

Fig. 89.—Spica of the foot.

Fix the initial extremity of the bandage around the ankle and carry the roll obliquely down across the dorsum of the foot,

Fig. 90.—Complete bandage of the foot.

making a circular turn around the toes. Cover the foot as far as the instep with a spica or spiral reversed turns. Then pass down across the point of the heel and back across the instep. The turn then passes down under the sole of the foot, obliquely up around the heel, and under the malleolus of the same side to the instep again. Then pass to the sole of the foot, up under the malleolus of the other side, and around the heel to the starting-point. Finally secure the bandage by a few turns around the ankle.

Uses.—To retain dressings and exert uniform pressure.

Spiral Reversed Bandage of the Lower Extremity.—Use a roller two and a half inches wide and fourteen yards long.

Fig. 91.—Spiral reversed bandage of the lower extremity.

Fix the bandage about the ankle and cover in the foot by a spica. Continue up the leg using spiral turns until the circumference of the part begins to perceptibly increase, then substitute spiral reversed turns. Cover in the knee by spiral turns or by a figure-of-eight and continue up the thigh, using spiral reverses.

Uses.—To retain dressings and for support.

THE HANDKERCHIEF BANDAGE.

The handkerchief, or triangular, bandage is most useful in

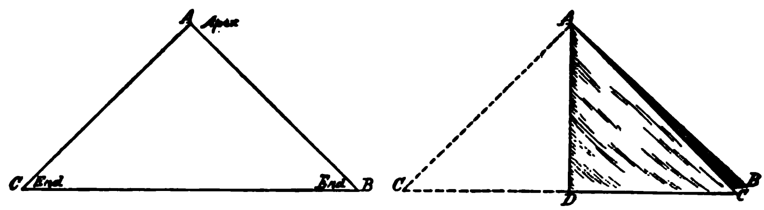

Fig. 92

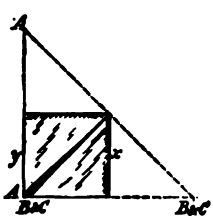

Fig. 93

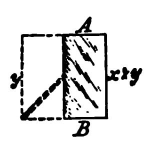

Fig. 94

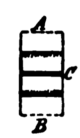

Fig. 95

Fig. 96

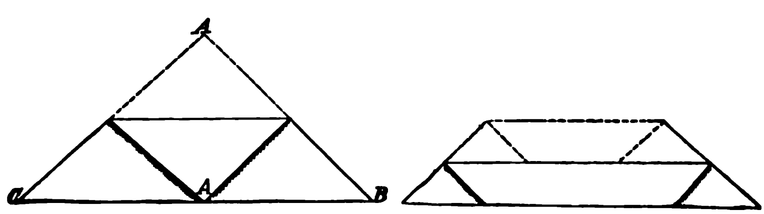

Fig. 97

Figs. 92–97.—Method of folding the handkerchief bandage (A. S. M.).

emergencies, as it may readily be made from a large handkerchief or piece of cloth, and its application is not a matter of great difficulty. It may be used in dressing wounds, for supporting fractures, as a means of controlling hemorrhage, and for slings. In fact it can be put to all the uses of the roller bandage, and on account of the small space it occupies when folded—being easily placed in the pocket—it makes an excellent dressing to carry upon the field.

Manner of Making the Bandage.—A piece of muslin or linen about a yard square is cut diagonally from opposite corners into two triangles, or the square may be folded once upon itself, thus forming a triangle.

To Fold the Bandage.—When not in use or for the purpose of making a convenient package for transportation, the bandage may be folded as follows: Spread the material out on a flat surface and fold it through the center, bringing the end *C* over to the end *B*, as shown in Fig. 92. Next bring the apex *A* over to the end *D* and the ends *B C* to the end *D* (Fig. 93).

A square is thus formed, which is folded in half, bringing side Y to side X (Fig. 94).

We now have a quadrilateral. Fold its two sides *A* and *B* over, making them meet in the center *C* (Fig. 95).

Finally, to make more compact, bring the side X over to the side Y (Fig. 96).

A handkerchief bandage may be used in the form of a triangle, as a cravat, or as a cord.

To fold a cravat, bring apex *A* to the base. Repeat this, folding the bandage lengthwise upon itself several times (Fig. 97).

To form a cord, continue folding till a narrow strip is formed.

FORMS OF HANDKERCHIEF BANDAGES.

The Square Cap.—Take an ordinary piece of muslin a yard square and fold it into a quadrilateral with the upper portion three inches shorter than the lower. This is then laid over the head with the shorter portion uppermost; the longer portion should overhang the face, while the shorter portion just covers the forehead. The two ends of this shorter portion are now tied

Fig. 98.—Application of the square cap.

Fig. 99.—The square cap completed.

under the chin. The flap of the longer portion is turned back exposing the eyes. Its ends are carried behind the head and

Fig. 100.—Triangular bandage of the head.

tied, sufficient tension being employed to make the bandage fit the head snugly.

Uses.—To protect the head and retain dressings upon the scalp.

Triangular Bandage of the Head.—The base of the triangle is placed upon the forehead, and its apex is carried back over the occiput. The two ends of the triangle are tied over the forehead. The bandage is tightened by pulling upon the apex, which is then turned forward and fastened to the body of the bandage (Fig. 100).

Fig. 101.—Cravat bandage of the jaw.
Fig. 102.—Triangular bandage of the chest.

Uses.—To exert pressure and retain dressings upon the head.

Cravat Bandage of the Jaw.—Fold the triangle into a cravat as already described. The body of the cravat is applied beneath the chin. The two ends are carried up over the head, crossing each other upon the vertex of the skull. They then pass downward, and beneath the chin are made secure.

Uses.—For fractures of the jaw and wounds of the chin.

Cravat Bandage of the Eye.—Form a cravat and place its center over the injured eye. Carry the two ends obliquely around the head, one passing up over the forehead, and the other passing down over the ear. They cross behind the head, and, passing forward, are tied in front.

Fig. 103.—Cravat bandage of the eye.

Uses.—To retain compresses upon the eye.

Cravat Bandage of the Shoulder.—Fold a cravat and place its body in the armpit of the affected side. The ends pass up over the shoulder and cross each other, one passing around behind the neck and the other in front of the neck. They are secured under the opposite armpit.

Uses.—To retain dressings in the armpit or upon the shoulder.

Fig. 104.—Cravat bandage of the shoulder.

Triangular Bandage of the Shoulder.—Place the base of the triangle around the arm with its apex up over the shoulder. Carry the two ends around the arm, securing them on the outer side. A sling supporting the injured arm is then applied as shown in the accompanying illustration (Fig. 105), and the apex of the bandage is folded back over the sling and secured to the body of the bandage.

Uses.—For injuries of the shoulder.

Triangular Bandage of the Elbow.—Flex the forearm, fold a large hem in the base of the triangle, and place its center over the front of the elbow, the apex of the triangle being up. Carry the two ends of the triangle around the forearm once. After crossing in front of the joint, they pass up and around the arm, taking in the apex of the triangle. Secure the two ends, bring down the apex, and fasten it to the body of the triangle.

Uses.—To retain dressings upon the elbow.

Triangular Bandage of the Hand.—Place the base of the

Fig. 105.—Triangular bandage of the shoulder.
Fig. 106.—Triangular bandage of the hand.

triangle, with the apex down, upon the palmar or dorsal surface of the wrist, according to which surface is injured. Fold back the apex over the fingers to the wrist and secure it in place by tying the two ends around the wrist. The apex is then folded back and fastened to the body of the bandage (Fig. 106).

Uses.—To retain dressings upon the hand.

Cravat Bandage of the Hand.—Place the body of the cravat upon the palm of the hand and carry the two ends around the hand, crossing over the dorsum. The two ends then pass to the wrist, which they encircle, and are finally tied upon the dorsal surface.

Uses.—To exert pressure upon the dorsal surface of the hand.

Triangular Bandage of the Breast.—Place the base of the triangle under the affected breast with its apex extending over the shoulder of the same side. One end of the triangle is carried up over the opposite shoulder, and the other is carried down under the armpit. The two ends and the apex are then tied behind.

Fig. 107.—Triangular bandage of the breast.

Uses.—To support the breast.

Triangular Bandage of the Chest.—The base of the triangle is placed across the chest, and its apex is carried up over the shoulder of the affected side. The two ends of the triangle pass around the body, below the armpits, and are tied, the apex being fastened to them by a pin (Fig. 102).

Fig. 108.—Triangular bandage of the thigh.

Uses.—To retain dressings in injuries of the chest, or as a dressing for fracture of the ribs.

Triangular Bandage of the Thigh.—To apply properly, a cravat is also necessary. Fasten the cravat around the waist. Then place the base of the triangle with its apex upward around the injured thigh, and, after carrying the two ends around the thigh, secure them in front. The apex of the triangle is slipped under the cravat and is secured to the body of the bandage by pins.

Fig. 109.—Cravat bandage of the knee.

Uses.—To retain dressings upon the groin and upon the upper part of the thigh.

Cravat Bandage of the Knee.—Placing the body of the cravat above the knee-cap, carry its two ends around the limb, crossing behind; then carry them downward below the knee and tie around the leg.

Uses.—To hold fragments of a broken patella in apposition.

Triangular Bandage of the Foot.—Place the base of the triangle behind the ankle. The apex is carried forward under the sole of the foot, and up over the toes to the front of the ankle. The two ends pass forward around the ankle, including the apex. After crossing each other, they encircle the foot and are tied upon the dorsal surface. The apex is then folded back and pinned to the body of the bandage.

Fig. 110.—Triangular bandage of the foot.

Uses.—To retain dressings upon the foot.

Triangular Bandage of a Stump.—Place the base of the triangle above and behind the stump. Bring the apex up over the end of the stump and encircle it with the two ends, which are then tied. The apex is folded back and fastened to the body of the triangle.

Uses.—To retain dressings upon a stump.

OTHER FORMS OF BANDAGES.

The T-Bandage consists of two strips of muslin or flannel,—a horizontal piece, sufficently long to pass once or twice about the part to which it is to be applied, and a vertical piece, half as long as the horizontal strip, to the center of which it is attached. This bandage may be applied to the head or perineum for purposes of retaining dressings.

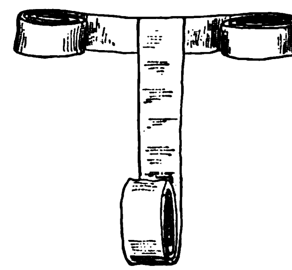
Fig. 111.—T-bandage (Stoney).

As a dressing for the head, the horizontal piece is carried around the cranium, while the vertical strip crosses the top of the head and passes beneath the first piece on the opposite side, to which it is fastened.

Four-tailed Bandages are made by splitting each of the two extremities of a broad strip of muslin into two tails to within a short distance of the center. Such bandages are used for fractures of the lower jaw, as a temporary dressing for fractures of the clavicle, and to retain dressings upon the head.

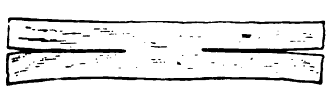
Fig. 112.—Four-tailed bandage (Stoney).

In applying this bandage to the jaw, the two ends of a piece of muslin four inches wide and one and a half yards long are torn into two tails to within five inches of each other. The central portion of the bandage is placed over the chin, the two lower tails are carried up over the head and are there tied, while the two upper tails are carried behind the neck and tied (Fig. 113).

The Many-tailed Bandage, or Bandage of Scultetus, may be made by splitting the extremities of a narrow piece of muslin, or, if a broad piece, its sides into a number of tails to within a few inches of its center. The width and length of the bandage will vary according to the size of the part to which it is to be applied. The many-tailed bandage is a most useful appliance for holding dressings in place upon the abdomen, or for furnishing support to that region, it being also used as a dress-

Fig. 113.—Four-tailed bandage of the jaw.

ing for injuries of the extremities. (If used for the latter purpose, the bandage is modified as shown in Fig. 115.)

The bandage may be made by simply cutting an ordinary roller bandage into a sufficient number of pieces to cover the part, each piece being long enough to encircle the part and overlap for a distance of two or three inches. The centers of the various pieces are applied beneath the part in such a way that they overlap each other, the extremities of the last piece being made secure by pins. If applied in this way, new strips can be inserted at any time in place of those that may become soiled without disturbing the limb.

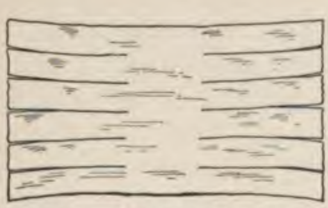

Fig. 114.—Many-tailed or Scultetus bandage (Stoney).

Borsch's Eye Bandage is applied as follows: First carry a circular turn of a roller bandage around the head, covering in both eyes. To this a narrow piece of bandage is fastened behind and is carried up over the head to the sound eye. It then passes beneath the first turn and is folded back, just sufficient traction being made to raise the bandage from the uninjured eye. The end can be then secured by pins.

Fig. 115.—Modified Scultetus bandage (Stoney).

SLINGS.

Slings are employed as a means of support for the extremities following an injury. They may be made from an ordinary bandage, a cravat, or a triangular bandage.

Ordinary Sling.—A roller bandage or a cravat about four inches wide is obtained. A loop supporting the injured arm is formed, and the two ends are tied behind the neck.

Fig. 116.—Borsch's eye-bandage (Da Costa).

Triangular Sling.—Place the base of the triangle under the wrist of the affected arm, with the apex extending out behind the elbow. The end nearest the body is carried up over the opposite shoulder, while the other end is carried up over the shoulder of the injured side. The two ends are tied behind the neck, while the apex is folded forward from behind the elbow and fastened to the body of the bandage in front (Fig. 117).

Triangular Sling (where the Shoulder of the same side is Injured).—In this case the sling must be arranged so as not

Fig. 117.—Triangular sling.

Fig. 118.—Triangular sling.

to press upon the injured shoulder. Arrange the triangle as before, and carry the end nearest the body up over the opposite shoulder. The other end is carried beneath the arm of the injured side and up behind the shoulder of the other side, where the two ends meet and are tied. The apex of the bandage is pinned to the body of the sling (Fig. 118).

Triangular Sling (where the opposite Shoulder also is Injured).—Arrange the triangle as before, but carry the end nearest the body up in front and over the shoulder of the injured

Fig. 119.—Triangular sling.

side. The other end passes beneath the arm and up behind the shoulder, where it is tied to the first end. The apex is then pinned to the body of the triangle (Fig. 119).

An arm-sling may also be improvised by utilizing the coat-sleeve as a means of support. The injured arm is placed across the chest with the hand beneath the opposite side of the coat between two buttons. The sleeve is then made secure to the coat by pinning at the wrist and elbow-joint.

CHAPTER X.

DRESSINGS AND PRACTICAL REMEDIES.

ADHESIVE PLASTERS.

Adhesive plaster is used extensively in surgery for the purpose of holding dressings and splints in position, as a method of approximating the edges of wounds, and for the fixation of fractures, sprains, and strains.

For these purposes ordinary rubber adhesive, or what is known as moleskin, or resin plaster, may be used. The plaster is cut into strips of the required width and length and, in the case of the resin plaster, requires to be heated by passing through a flame before application; rubber adhesive will adhere to the skin without heating, but has the disadvantage of producing an irritation of the skin when applied for any length of time. There is a rubber adhesive, known as "Z.O." plaster, which has all the adhesive properties of ordinary rubber plaster without producing this irritation, and for this reason is far preferable to the former. If the plaster is to be applied to a part on which there is any hair, the skin should be first shaved, otherwise the removal of the plaster will be very uncomfortable for the patient.

Strapping Dressings and Splints.—For this purpose strips of plaster one to two inches wide are used.

To secure a dressing to a part a number of these strips should be applied at intervals of one to two inches, and each strip should be long enough to reach an inch or two beyond the dressing without entirely encircling the part. Before applying, the tips of the strips should be so folded that the adhesive surfaces are in apposition, thus preventing the extreme ends of the plaster from adhering to the skin. If this is done it will be found that the removal of the strips will be facilitated.

Another method of holding dressings in place is by the use of adhesive plaster combined with strings or tapes. Short strips of plaster are fastened to the skin at intervals near the outer edges of the dressing, to the free ends of which are attached tapes, fastened through holes in the plaster. These tapes are tied over the dressing, as much tension being employed as is wished. This method has this advantage,—that the dressings may be removed without disturbing the plasters by simply untying the tapes; it is very useful where dressings have to be frequently changed.

Bandages may be secured by small strips of adhesive which fix the terminal extremity to the body of the bandage.

Strapping splints in place with adhesive is an excellent method to prevent them from slipping. The strips should be applied around the splints in at least three places,—top, middle, and bottom. A bandage may be applied over this, if so desired.

Strapping Wounds.—In the treatment of wounds adhesive straps are often employed in the place of sutures, and, if carefully applied, as accurate an approximation of the divided edges can be obtained as from sutures. They also have an advantage over sutures in that scars resulting from the insertion of the stitches are avoided.

Narrow strips should be applied at frequent intervals across the edges of the wound, but should never entirely encircle a limb. The ends of the strips are fastened to one side of the wound, and, while the edges of the wound are held in apposition, the other ends are carried across the wound and applied to the skin beyond.

Another method is by the application of two strips. A longitudinal slit is cut in the center of one strip, and the sides of the other strip are cut away at its center so that it will fit into the slit in the first strip. The second strip is then threaded through the slit in the first, and one end of each strip is fastened on opposite sides of the wound, the free ends being drawn on sufficiently to bring the edges of the wound in apposition, and they are then fastened (Fig. 120).

The second strip should be applied in such a way to the elbow that it forces it forward and throws the shoulder back. The portion of the plaster over the elbow should be slit for an inch or two to receive the point of the elbow.

Strapping Joints is a useful method of treating sprains, serving to exert pressure upon the joint and support the injured ligaments. It is applicable especially to the ankle, knee, wrist, and elbow-joints.

Strips of plaster about one inch wide are firmly applied in sufficient number to cover the joint, each strip overlapping the previous one and extending about two-thirds around the joint.

Fig. 124.—Strapping an ankle-joint.

DRESSINGS.

The most desirable form of dressing for wounds consists of dry sterilized gauze or antiseptic gauze. The gauze can usually be obtained in air-tight packages, sterilized and ready for use. Should it not be available, ordinary lint, flannel, muslin, or even a clean handkerchief or a clean rag, may be used; but they should, if possible, be rendered sterile before using by boiling for fifteen minutes. In emergencies, however, dressings may be quickly rendered sterile by soaking them in an antiseptic solution, such as corrosive sublimate (1:2000), carbolic acid

(1:100), or a saturated solution of boric acid. Gauze or muslin soaked in alcohol, salt and water, or vinegar, may be employed when nothing better is at hand. An excellent dressing for small, clean cuts consists of flexible collodion. This is a liquid preparation which can be applied over a wounded surface with a small brush, and, upon exposure to the air it hardens, forming a thin skin or protective. A thin layer of cotton saturated with collodion forms a more substantial dressing than the collodion alone.

SUTURES.

Sutures are employed to bring the edges of cut surfaces in apposition and hold them in place until healing is effected. The materials used for this purpose are catgut, silk, silkworm-gut, silver wire, horse hair, and kangaroo tendon. Of these, catgut and silk are most used. The advantage in using catgut lies in the fact that it is soon absorbed by the tissues and does not have to be removed; silk, on the other hand, remains in the tissues unabsorbed. The sterilization of catgut is rather complicated, and it had better be obtained already prepared. Silk can be obtained in the same condition, or it may be sterilized by boiling for fifteen minutes or immersing in an antiseptic solution. There are many forms of sutures employed, but a description of the interrupted and the continuous suture only will be given.

The Interrupted Suture consists of single stitches inserted at a distance of about one-quarter to one-half inch apart. The needle, threaded with the suture, passes through the skin about one-eighth inch from the cut edge and on out through the oppo-

Fig. 125.—The interrupted suture (Zuckerkandl).

site side at a corresponding point. The suture is then tied and the ends cut, leaving about one-quarter inch remaining. Care should be taken in tying the suture to use but little tension,—sufficient only to bring the cut edges in accurate approximation. The remaining stitches are inserted in the same manner until the wound is closed.

The Continuous Suture.—The first stitch is started in the same manner as for an interrupted suture and is tied, but the end to which the needle is attached is not cut. The subsequent

Fig. 126.—The continuous suture (Zuckerkandl).

stitches are then inserted as for an interrupted suture, but are not tied until the last stitch is taken. It may then be tied by drawing the suture through double and securing the free end to the double end.

Tying Knots.—It is very important in tying a suture or ligature to do it in such a manner that the knot will not slip or become loosened. To avoid this, always use either the reef-knot or the surgeon's-knot.

The Reef-knot.—Begin by taking one end of the suture in each hand. The end in the right hand is now passed beneath

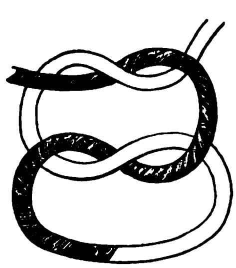

Fig. 127.—Method of tying square or reef-knot.

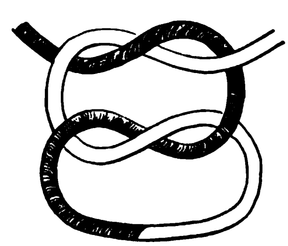

Fig. 128.—The granny-knot.

and around the one in the left hand, and the two ends are tightened. The end that was originally in the right hand will now be in the left hand. The same end is taken again and is passed beneath and around the end in the right hand, and the resulting loop is tied. Care should be taken not to tie a granny-knot, which is insecure. This is started in the same manner as for a reef-knot, only the end in the right hand passes *beneath* that in the left hand each time.

The Surgeon's-knot is tied in the same way as a reef-knot, only a double turn is taken in the first hitch. This gives added security and prevents slipping while tying the second knot. The second knot is completed in the same manner as for a reef-knot.

Fig. 129.—Method of tying surgeon's knot.

NEEDLES.

The best form of needle for the skin is a spear-pointed one, or a needle which has a cutting edge, commonly known as a Hagedorn needle. Straight or curved needles can be used according to preference. If nothing better is at hand, ordinary round-pointed cambric needles may be used, but it will be found that they are difficult to push through the skin. Needles may be sterilized by boiling for five minutes; a little soda added to the water will prevent rusting.

"FIRST AID" OUTFIT.

For the benefit of those who, being in a locality where accidents are of frequent occurrence or where medical supplies are not easily obtained, wish to properly equip themselves for the treatment of ordinary emergency cases, a list of a few necessary articles is given.

Such an outfit should contain half a dozen bandages varying from one to four inches in width; a spool of adhesive plaster, two inches wide; a tourniquet; a roll of absorbent cotton; a package of sterile gauze; a package of antiseptic (bichloride) gauze; half a dozen tubes of sterilized catgut and silk; three or four surgeon's needles of medium size; a pair of scissors; a hand brush; a small basin; a bottle of liquid soap; a bottle of bichloride of mercury tablets; a small bottle of carbolic acid; and a small flask for whiskey. The above outfit, obtainable from almost any druggist at little expense, can be readily packed away in a small box and should be sufficient for all practical purposes. To this may be added a pocket case containing one or two knives, scissors, probe, artery clamps, etc.

In the army each soldier is provided with a small first aid

Fig. 130.—"First aid" outfit.

or field dressing outfit consisting of two antiseptic compresses, an antiseptic bandage, a handkerchief bandage, and safety pins. All are contained in a small waterproof package, upon the outside of which are directions as to the manner of applying, etc.

THE USE OF COLD AS A REMEDY.

Cold applied generally over the entire surface of the body is a means of reducing the bodily temperature in fevers. Cold acts locally by producing a contraction of the blood-vessels. By thus limiting the amount of blood to a part it not only prevents congestion and inflammation, but it also relieves pain to a great extent by taking the pressure of the blood from the terminal nerves.

As a means of reducing high bodily temperature cold is usually employed in the form of a cold sponge or cold tub. Either method to be efficacious must be accompanied by a thorough rubbing of the surface of the body during the bath. This friction is very necessary in order to bring the overheated blood to the surface of the body, from which the heat may be abstracted. The action of cold is only a temporary one, and in long-continued fevers it is often necessary to give baths every three or four hours to control the temperature.

The Cold Sponge.—In giving a cold sponge, there will be required one or two large sponges and several pails of cold water. The temperature of the water should be from 75° to 32°, according to the age and condition of the patient. For old people tepid water only should be used, as they react very poorly. The bed is covered by a rubber sheet, and the patient lies upon this, having been previously stripped. The body is then sponged off, only enough water being used to just dampen the surface. In this way evaporation occurs quickly, and more heat is abstracted. While the sponging is going on, constant friction of the body with the hands must be kept up. Usually sponging for ten or fifteen minutes will be sufficient to reduce the temperature several degrees. It is not safe to reduce the temperature too rapidly, as a collapse might result. The patient is finally put to bed and lightly covered with a sheet or thin blanket. Should he complain of being cold after the bath, some brandy or whiskey may be given.

The Cold Tub.—A portable tub, while not absolutely necessary, will be found of great assistance in giving this form of bath. The tub is about half filled with water, between 70° and 60° in temperature, and the patient is immersed in this for from ten to twenty minutes. Constant friction with the hands must be kept up over the entire surface of the body during the time the patient is in the water, and, to prevent cerebral congestion, ice or an ice-cap should be applied to the head. As a rule a patient will shiver and complain of being cold while in the bath, but this is not a sign of any danger; should he, however, remain cold afterward, a stimulant may be given and bottles of hot water applied to the feet. If the patient is weak a stimulant, such as whiskey or brandy, may be given both before and after the bath.

The Local Application Of Cold.—Cold may be applied locally to a part by means of cloths wrung out in ice-water and frequently changed or by the use of ice. The ice is first cracked very fine and then placed in an ice-bag. If an ice-bag is not

Fig. 131.—Ice-bag (Ashton).

available, any waterproof bag will answer the purpose equally well. The ice-bag is especially useful in injuries about the head, inflammation of the brain, and in sunstroke.

HEAT.

Heat, locally applied, produces a contraction of the blood-vessels in a part, and thus has practically the same effect as cold. It may be used for the same purposes as cold, the choice of one over the other depending in the main upon the preference of the patient.

Hot Fomentations may be applied as follows: A compress of flannel or lint is wrung out in boiling water and, while still hot, is applied to the affected region, being changed as soon as it becomes cool. It is always well to cover the compress with oiled silk to prevent a too rapid cooling and evaporation. In order to avoid burning the hands, the compress should be quickly lifted from the boiling water and transferred to a towel, when it can be wrung out by twisting the towel upon itself, as shown in the accompanying illustration.

Dry Heat.—For this purpose hot-water bags, hot bottles, heated bricks, heated salt, bran, or sand placed in a bag, may be used. This form of heat is most useful when applied to the extremities in the treatment of shock or collapse. Great care must be taken in the application of heat to the body of an unconscious person not to produce a burn. It should be remembered that a person in such a condition is unable to offer any complaint, even though he be burned, and it is not uncommon that

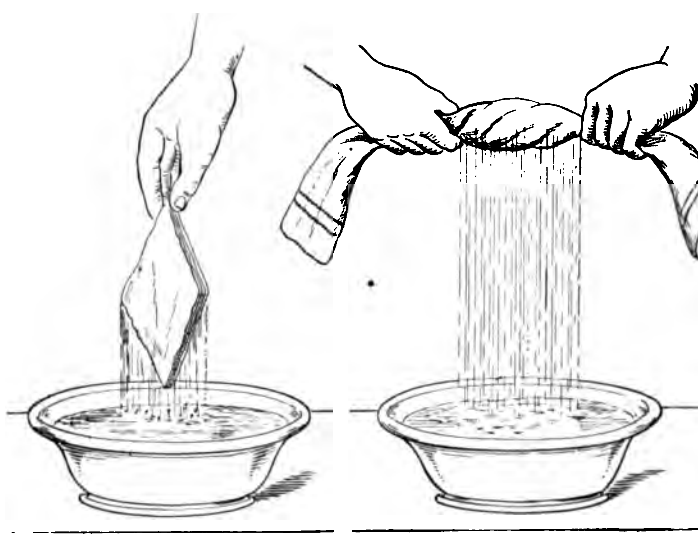

Fig. 132.—Method of wringing out a hot compress without scalding the hands (W. Easterly Ashton).

the tissues of such a person are less able to withstand heat than ordinarily. Never apply this form of heat directly to the skin without interposing flannel or some other material.

The Hot-Pack.—The hot-pack is employed to increase the activity of the skin and to produce sweating. It is frequently used in diseases of the kidneys as a means of ridding the system, through the skin, of poisonous materials which are normally excreted through the kidneys.

A hot-pack may be given as follows: The bed is first covered by a rubber sheet and a heavy dry blanket. On top of this is placed a large blanket wrung out in hot water. The patient, being stripped, is laid upon the bed thus prepared and is carefully wrapped in the hot blanket. Hot water bags are then placed about his body, and he is snugly covered with the dry blanket and rubber sheet, leaving the head alone exposed. Ice or an ice-cap should be placed upon the head to prevent cerebral congestion. The patient is left in the pack about an hour. Should sweating fail to appear, he may be given a glass of cold water to drink; this will usually result in producing a profuse perspiration. The temperature of the patient should be frequently taken and, if it begins to rise and no sweating appears, the pack should be discontinued.

POULTICES.

Poultices are used in deep-seated inflammations or as an aid in separating sloughing or dead tissues from the healthy tissue.

Flaxseed Poultice.—To a vessel of boiling water, slowly stirred, is added ground flaxseed until the resulting mixture is about the consistency of mush. This is then evenly spread about one-quarter of an inch or more in thickness upon a clean piece of linen or muslin, the margins of which are doubled back to prevent the flaxseed escaping. After the poultice has been applied to the skin, it should be covered with cotton or oil silk to keep it from cooling too rapidly.

Charcoal Poultice.—It may be prepared by adding equal parts of flaxseed meal and animal charcoal to boiling water. The resulting mixture is spread evenly on a cloth and applied in the same manner as a flaxseed poultice. Charcoal poultices are useful applications for foul, sloughing wounds.

COUNTERIRRITANTS.

They act by causing a dilatation of the vessels of the skin and reflexly by contracting the deeper vessels. The mustard plaster and turpentine stupe are the most commonly used. They are employed to relieve deep-seated pain and inflammation.

Mustard Plaster.—Take two and a half parts of flaxseed meal, and stir into ten parts of boiling water; to this add two and a half parts of powdered mustard, and stir well. The resulting mixture may be spread between two pieces of muslin and applied to the skin. In order to prevent blistering in children or old people, it will be necessary to add more flaxseed and thus dilute the strength of the plaster.

A mustard plaster may also be made by taking equal parts of mustard and ordinary flour, to which is added sufficient water to form a paste. This is spread between two pieces of muslin, a piece of stiff paper being placed behind the plaster to give it added firmness.

Turpentine Stupe.—Place some turpentine in a small vessel surrounded by hot water and leave it till warm. A piece of flannel is next wrung out in very hot water, dipped in the turpentine, and then again wrung out; the flannel should be applied to the skin while hot, but should not be allowed to remain long enough to produce a blister. *Never attempt to warm the turpentine over a fire.*

ENEMATA.

Enemata, or injections of fluids into the bowels, are of several kinds and have a variety of uses. Those given to produce an evacuation by the bowels are known as purgative enemata. Another class, spoken of as nutritive enemata, are employed to administer food or drugs by the rectum. Again, in the treatment of shock or hemorrhage, large quantities of salt solution are frequently injected into the bowels, and these are known as saline enemata. The usual way to give an enema is by means of a rubber syringe having a smooth hard rubber nozzle. The fluid to be injected should be in a basin placed near at hand. Then, with the patient on his side, the nozzle of the syringe, previously well lubricated, is gently inserted into the rectum. The injection should be given slowly and without the use of any force, and care must be taken to avoid getting air into the syringe.

Purgative Enemata.—A mild purgative enema consists of two pints of warm water well mixed with soap until the resulting mixture begins to thicken; such an enema is known as a simple enema. A stronger action can be obtained by adding half an ounce of Epsom salts, half an ounce of turpentine, an ounce of glycerin, or an ounce of castor oil to the above enema.

Nutritive Enemata.—In some cases where it is impossible to give food or drugs by the stomach, the fact that fluids are readily absorbed by the rectum is taken advantage of, and the nutritive enema is employed. A patient may be fed by the bowels almost indefinitely, if proper care is observed in preparing and administering the food. The main difficulty to prolonged feeding by rectum is that the bowel soon becomes irritated and fails to retain the fluids introduced. The enema should always be given warm—that is, at about the temperature of the body—and the amount introduced should be small, as it is then more liable to be retained. Avoid giving any irritating substances and give only such food as is easily absorbed. As an aid to absorption, it is well to clean out the bowels by a simple enema a short time before the nutritive enema is given. Nutritive enemata may be given every two or three hours.

A good nutritive enema consists of the whites of two eggs, half an ounce of beef tea, two or three teaspoonfuls of brandy, and six ounces of warm water.

Another good combination is made of one raw egg, half an ounce of whiskey, a pinch of salt, and six ounces of milk.

Saline Enemata are often used as a means of restoring the volume of fluid to the circulation after a great loss of blood from hemorrhage. The injection of salt solution into the rectum is also an excellent form of treatment for shock or collapse.

The solution is prepared by adding a teaspoonful of salt to a pint of boiled water. A pint or a quart of this solution, heated to 110°, is the amount usually given. If a stimulating effect is desired, add from half an ounce to an ounce of whiskey to the enema.

HYPODERMIC INJECTION.

In cases where a rapid effect from drugs is desired, or where it is impracticable to give them by mouth, they may be given hypodermically. For this purpose a small syringe with a graduated glass barrel and a fine, hollow, needle-like point is required. Before using, the needle must be sterilized by boiling

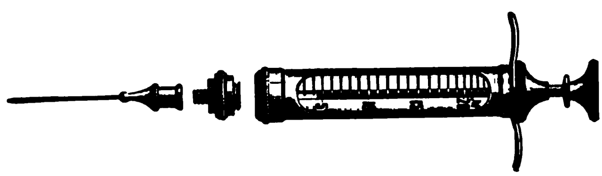

Fig. 133.—Hypodermic syringe.

or by immersion for a few minutes in an antiseptic solution. To fill the syringe, place the needle in the medicine to be given and draw back the piston until the desired amount—which usually consists of but a few drops—is obtained. Most of the drugs employed for hypodermic use are put up in the form of soluble tablets, and before using are dissolved in ten or fifteen drops of

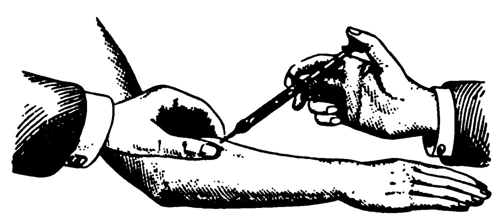

Fig. 134.—Method of giving a hypodermic injection (Thornton).

boiled water. At this point it is well to see that no air remains in the syringe. By elevating the syringe and pressing upon the piston any air that may be present will be expelled. The usual site for giving the injection is upon the outer surface of the arm or thigh. The spot chosen must be first washed, and then cleaned off with alcohol; then pinch up the skin with the thumb and fore-finger of one hand, and with the other thrust the needle beneath the skin and inject the contents of the syringe. The needle is then carefully withdrawn, and a finger is held over the spot for a moment to prevent the injected fluid from escaping. After using the needle, be careful to thoroughly clean and dry it, as it is very apt to rust and clog up inside. The latter may be prevented by running a fine wire through it before putting away.

PREPARATION IN THE HOUSE FOR AN ACCIDENT CASE.

Before an individual, suddenly taken sick or injured, is removed to his home, the family should be notified by a messenger sent on in advance so that some preparations may be begun for the comfort of the sufferer. The sudden arrival of an injured person at his home without any warning is an unnecessary shock to the family, and frequently throws the household into such a state of excitement that no intelligent aid can be rendered and much valuable time may be lost. Always give some definite information about the nature of the injuries, *and never summon a doctor without stating what sort of a case he is to treat*, so that he may come properly prepared.

Things Usually Needed.—The following supplies should be prepared in readiness for any case of sudden injury,—namely, plenty of hot and cold water; one or two bowls or dishes; a slop-pail for dirty water; soap; a scrubbing brush for the hands; clean towels; sheets; and some whiskey or brandy. There should be provided in addition:

For hemorrhage, boiling water, sponges, clean linen or gauze, and bandages.

For fractures, plenty of cotton, splints or some material from which they can be made, bandages, and adhesive plaster.

For burns, olive oil, lard, vaseline, or carron oil, clean linen or lint, and bandages.

For shock, hot water bags or bottles, and warm blankets.

For sunstroke, plenty of cold water and ice.

The Sick Room.—The room which a sick person is to occupy should be selected with some forethought for the patient's comfort. Choose a room in some part of the house away from all noise, yet easily accessible,—preferably a room which has a southern exposure, so that the patient can have the benefit of the sunshine.

The room should be larger than would be necessary for an ordinary sleeping apartment, because there are usually one or more persons present besides the patient himself to consume the oxygen from the air. Bare floors are much cleaner than carpets, and for the same reason curtains, fabrics, hangings about the bed, all unnecessary furniture, and, in fact, anything that is liable to collect dust, should be removed. The room should be kept at an even temperature—not lower than 60°—a thermometer being hung in the room especially for the purpose of regulating the temperature. If the weather is cold, some means of heating will be required, preferably a large open fire which does not smoke, as, in addition to the heat, a means of ventilation is thus provided through the draught up the chimney. Good ventilation of a room is very important and necessary for the sick, and the air should never be allowed to get stuffy or stale. In providing for ventilation, however, see that the patient is not in a draught.

The Bed should be narrow, accessible from both sides, and out of any draught. A clean hair mattress is preferable. Avoid soft beds. If there is a liability of discharges from wounds or moisture from wet dressings to soak into the mattress, a rubber sheeting or oilcloth, covered by a blanket or sheet folded into several thicknesses, should be applied over the under sheet as a protection.

The "Fracture Bed."—The bed in which a patient with a fractured limb is to remain must be fairly narrow, as with a very wide bed it will be impossible to move or properly attend to him. Have the bed in such a position that it will be accessible from each side.

The mattress should be firm and flat, with no possibility of sagging, yet at the same time smooth and elastic. A hair mattress, or a wire mattress covered with several thicknesses of blanket, is preferable. Never use a feather bed or feather mattress. An ordinary iron bed with springs is apt to sag too much. To avoid this, some boards should be placed between the springs and mattress.

For fractures of the lower extremity the foot of the bed should be raised a few inches to prevent the weight of the body pressing down upon the broken fragments. A couple of wooden blocks inserted under the legs of the bed will accomplish this. It is also well to rig up some sort of an apparatus at the foot of the bed to take the weight of the bedclothes from the injured limb. Two narrow boards, fastened at their ends to form a right angle, with the long arm secured to the foot of the bedstead and the short arm pointing toward the patient, a cradle, or, if the bed is narrow, half of a barrel hoop made secure at each end to the sides of the bed, will answer.

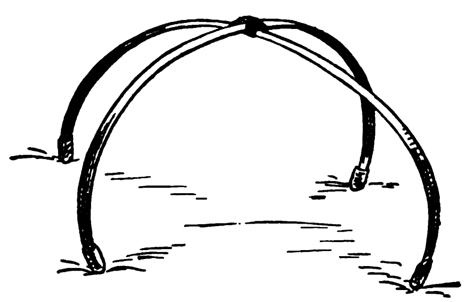

Fig. 135.—Cradle to keep bedclothes from a fractured leg, made from two barrel hoops (Scudder).

Preparations for an Operation.—Frequently, in an emergency, operations have to be performed on very short notice, and much assistance can be rendered the surgeon if there is some one about who can direct the necessary preparations.

Procure a room with plenty of light,—if possible near the room to be afterward occupied by the patient. Have all the superfluous furniture, curtains, hangings, and carpets removed, and the room cleaned, if there is time. If time is of prime importance, simply protect the carpet from soiling by oilcloth, rubber sheeting, tarred paper, or newspapers. The room should be well heated, as the patient may be more or less exposed during the operation.

For an operating table nothing answers better than a large, strong, kitchen table. It should first be covered with a rubber sheet or oilcloth, then a blanket, and finally a clean sheet. One or two small tables should be provided for instruments, solutions, etc. Flat-bottomed chairs will answer if tables are not available.

Plenty of hot water, cold water previously boiled and allowed to cool, several large, clean pitchers, three or four medium-sized pans, a large slop-pail, soap, hand-brush, safety-pins, clean towels, and sheets should be also provided.

CHAPTER XI.

ANTISEPSIS AND DISINFECTION.

SEPSIS AND ANTISEPSIS.

Sepsis is a condition caused by the entrance into a wound of bacteria whereby an inflammation, with more or less severe disturbance of the general system, is produced.

Antisepsis (meaning germ-destroying) is a term applied to a method of treating wounds which aims at the destruction of germs by germicidal agents.

The subject of sepsis and antisepsis is considered to be one of the most important in all modern surgery, and the application of the principles of antisepsis has done more than anything else to revolutionize the treatment of wounds and prevent sepsis, a complication so dreaded by the older surgeons.

Causes of Sepsis.—Why is it that a simple cut will sometimes heal naturally in a few days, and at other times become red, painful, and very swollen, finally healing, it is true, but only after much trouble and discomfort? In the latter case the wound has become infected by bacteria, and poisonous materials have been produced which have prevented its healing. The bacteria may have been conveyed by the instrument producing the wound. They may have come from the hands or from the air, or they may have been present upon the skin and gained entrance through its broken surface. Whatever the mode of entrance may have been, the result is the same,—the bacteria have entered the system, invaded the tissues, and, by their growth, caused putrefaction, or sepsis.

Bacteria are microorganisms, or fungi, consisting of minute vegetable cells. They are always present in the air, in the water, in the ground, and upon the body and clothes. There are many varieties of bacteria, and each requires proper food, temperature, and soil for propagation. Having found a suitable soil or breeding place in the tissues of the body they multiply with a rapidity that is simply marvellous. As they grow and develop, certain poisonous substances, termed *toxines*, are produced, which may act simply as irritants or may destroy all the tissues with which they come in contact,—the effect depending upon the virulence of the bacteria and the resistance of the tissues. In other cases bacteria may gain access to the general circulation and be spread broadcast through the body, exerting their poisonous influence upon every organ which they touch,—in short, producing a general poisoning known as septicemia.

GERMICIDAL AGENTS.

Heat is the quickest and surest agent known for destroying bacteria. No living germ is able to withstand a temperature of 212° F. (100° C.). Heat, of course, cannot be applied to wounds as a means of sterilization, but it may be used to sterilize water, dressings, or instruments, in the form of dry heat, steam, or boiling water.

Water may be rendered sterile by boiling for a few minutes. Instruments are best sterilized by boiling from five to fifteen minutes; a little soda added to the water will prevent rusting.

Dressings or fabrics are usually sterilized by steam under pressure, a sterilizer especially made for this purpose being required. If a sterilizer is not available, an ordinary baking oven may be utilized. The material to be rendered sterile should be wrapped up and securely pinned in a towel or sheet and left in the oven at least half an hour. In emergencies, the dressings may be sterilized by boiling for fifteen minutes.

Bichloride of mercury, or corrosive sublimate, is one of the best chemical germicides we have. It is used in a watery solution in a strength of from 1 : 10,000 to 1 : 1000. For the hands it may be used as strong as 1 : 1000, but for wounds a solution of 1 : 2000 or 1 : 5000 is better. A solution of approximately 1 : 1000 may be prepared by adding fifteen grains of bichloride to one quart of water. Weaker solutions of any strength may be prepared by diluting the above solution with one, two, three, etc., times as much water. Colored tablets of this drug are manufactured especially for the purpose of making solutions of any given strength. Bichloride of mercury is extremely poisonous, and, having no color or odor, the solution may easily be mistaken for water. To avoid this, it is customary to color solutions with eosin or some other dye. Instruments should never be placed in a solution of bichloride of mercury, as the mercury is deposited upon the steel, and not only tarnishes the instrument but ruins its cutting edge. An inflammation may be produced if the drug is used upon the skin in very strong solutions.

Carbolic acid is another excellent germicide and, like corrosive sublimate, is very poisonous. Upon the skin, it may be used in a solution of 1:100. It should be used with care, however, as it is readily absorbed, and poisoning is apt to follow prolonged use. For sterilizing instruments, a solution of 1: 20 may be employed. A solution of 1:20 is obtained by adding to one quart of water one and a half ounces of pure carbolic acid; a solution of 1:100 would be prepared by adding the same amount of carbolic acid to five times as much water.

Boric acid is not so powerful a germicide as carbolic acid or corrosive sublimate, but on account of its nonirritating action it has a broader field of usefulness and may be employed about the eyes and in regions where stronger solutions are dangerous.

Other Germicidal Agents.—Among other agents which are germicidal but not as powerful as the above may be mentioned *salicylic acid*, *formalin*, *permanganate of potash*, *iodoform*, *iodine*, *peroxide of hydrogen*, *creolin*, *silver*, *bromine*, *chlorine*, *salt*, *alcohol*, *aristol*, etc.

PREVENTION OF SEPSIS—ANTISEPSIS.

To prevent wounds becoming infected by bacteria there are two indications to meet: (1) Prevent germs from entering the wound; (2) destroy or inhibit the growth of germs which may be already present.

To Prevent the entrance of Germs.—This can only be accomplished by the greatest care and cleanliness. The hands, instruments, and everything that comes in contact with a wounded surface must be absolutely clean,—and by clean we mean *surgically clean*, or *sterile*. Never touch a wound without first cleaning the hands, unless the delay resulting would be dangerous or fatal to the patient. Do not imagine because a wound is already dirty that lack of cleanliness on your part can do no harm. It is to be remembered that it is quite possible to introduce new and more dangerous forms of infection than are already present.

In treating an ordinarily clean wound, first of all thoroughly cleanse the hands by scrubbing for several minutes with a stiff brush in hot water and soap. Then rinse the hands in water that has been boiled, if possible, and finally immerse them for several minutes in a 1:1000 solution of bichloride of mercury. Having done this, be careful not to touch anything not sterile. Any instruments to be used should be either boiled or placed in a 1:20 solution of carbolic acid before using. The skin in the neighborhood of the wound should next be carefully cleaned, first with soap and water, followed by the use of some antiseptic. A sterile occlusive dressing is then applied to the wound.

To Destroy Germs already Present.—In the treatment of a dirty wound, or in a case where we have reason to believe the wound has already become infected, the same care as to the cleanliness of the hands and instruments should be observed as in the treatment of a clean wound. In addition, all particles of foreign matter should be removed, and the wound should be thoroughly washed and irrigated with an antiseptic solution. As a dressing gauze, saturated with some antiseptic, such as carbolic acid or bichloride of mercury, may be used.

Antisepsis must of necessity play but a small part in the treatment of emergency cases, yet the observance of its principles is as important in the immediate treatment of wounds as later. It is far easier to prevent damage than it is to repair damage already done; and we cannot fail to impress those who would render first aid with the importance of observing the strictest cleanliness in handling all wounds.

DISINFECTION.

Disinfection may be said to be a process of destroying infectious material. It is a subject that belongs more especially to the treatment of infectious diseases, but since a knowledge of the procedure in such cases is of the greatest importance in preventing the spread of diseases, and as it is a subject that is often neglected and but little understood, a short description of some of the methods of disinfection may not be out of place in a work of this kind.

Disinfecting Excreta.—During the course of an infectious disease it is important that all excreta and discharges from the patient should be disinfected and destroyed. The urine and feces should be received in a vessel or bedpan containing a solution of 1 : 20 carbolic acid. The solution used should be of such an amount that it will thoroughly cover the discharges. Care must be taken after coming in contact with such a case to thoroughly wash and disinfect the hands, using for this purpose a solution of 1 : 1000 bichloride of mercury or 1 : 40 carbolic acid.

Disinfecting Bedclothes.—When bedclothes are removed from the bed they should be soaked in a solution of bichloride of mercury (1 : 1000) before removal from the room. They must then be boiled for an hour or two, and, during this time, the lid of the boiler should remain closed to prevent any infectious matter being carried away with the steam,—of course, no food should be cooked in the same room while this is being done. Should mattresses become contaminated by discharges they must be burned, unless they can be disinfected in a steam sterilizer.

Disinfecting a Room.—The disinfecting and cleansing of a room occupied by an infectious case should be carried out with great care and thoroughness. The room should first be fumigated. For this purpose either sulphurous acid gas or formaldehyde gas may be used. Fumigation by sulphur is more easily carried out than by formaldehyde, as the sulphur can be readily obtained and an elaborate apparatus is not required. Still, sulphur is apt to bleach or destroy fabrics, and in a room with expensive hangings formaldehyde is the better. In either case, the room must first be as thoroughly sealed as possible to prevent any gas escaping; all keyholes, cracks, and crevices about the doors and windows should be carefully plugged with cotton.

Fumigation with sulphur is generally carried out as follows: A washtub or large pan is placed in the center of the room with about two inches of water in it, to prevent any burning sulphur spilling over and setting fire to the floor. Over this tub of water is placed a smaller pan resting upon two bricks. This pan contains the sulphur broken in small pieces. The sulphur may be ignited by dropping a hot coal on it, or by first saturating it with alcohol and then lighting with a match. Sulphur may also be obtained in the form of candles especially made for this purpose. The sulphur should be allowed to burn until consumed, and the room should not be opened for eight or ten hours. The amount of sulphur required will depend on the size of the room; to fumigate thoroughly, however, about four pounds of sulphur should be used to each 1000 cubic feet of space.

To use formaldehyde, a special apparatus is necessary to generate the gas. The generator is usually placed outside the room, and the gas discharged through the keyhole by a tube leading from the generator. It is a most penetrating gas, and after its use a room is uninhabitable for several hours.

In addition to fumigating the room, and as an added precaution, the walls should be brushed down, and all curtains or hangings should be removed and washed. The woodwork and floors should also be scrubbed, first with soap and water, and then with a 1:1000 solution of bichloride of mercury. The water with which this scrubbing is done must be afterward boiled, as it, too, may contain germs or infectious material.

After fumigating and cleaning a room, leave all the doors and windows open for several days to let in the air and sunlight, as they are the best disinfectants that could be employed.

PART III.

ACCIDENTS AND EMERGENCIES.

CHAPTER XII.

HEMORRHAGE.

Hemorrhage or bleeding may be defined as an escape of blood from the heart or blood-vessels. The cause is usually some injury or a diseased condition of the vessels.

A profuse hemorrhage from a large artery is one of the most troublesome forms of accident that one is called upon to treat, and to be successfully controlled requires presence of mind and promptness, as frequently the delay of a few moments may be followed by a fatal result. The danger from a hemorrhage depends upon the amount of blood lost and the rapidity with which it escapes,—a loss of one-third the amount of blood in the body usually results fatally, and a sudden escape of blood is much more dangerous than a slow or gradual hemorrhage.

Varieties of Hemorrhage.—(1) **Arterial Hemorrhage** is the result of the wounding of an artery. The blood is bright red in color and *escapes in spurts*. No pulsation can be obtained in the vessel below the seat of injury. Pressure upon the vessel between the wound and the heart arrests the bleeding.

(2) **Venous Hemorrhage** is bleeding from a vein. The blood is dark red or blue in color and *flows in a continuous stream*. Pressure upon the vessel beyond the seat of injury controls the bleeding.

(3) **Capillary Hemorrhage** is an oozing of blood from a cut surface.

Symptoms of Hemorrhage.—Hemorrhage may cause immediate death or simply result in syncope or collapse. Nearly all severe hemorrhages are accompanied by more or less shock. The skin is cold and pale; the body is covered with a profuse perspiration; the pulse becomes rapid and then feeble; the respirations are shallow and sighing. The person complains of darkness before the eyes, roaring in the ears, and difficulty in breathing, and continually begs for water. If recovery takes place, the patient remains pale and anemic for some time; and frequently a condition known as hemorrhagic fever supervenes.

The Spontaneous Arrest of Hemorrhage.—Fortunately, in the majority of cases, hemorrhage is arrested by nature before a fatal loss of blood occurs. When a vessel is cut through, the muscular fibers in its wall begin to contract, and at the same time the vessel's wall retracts within its sheath, so that the caliber of the vessel at the point of injury is partially closed or, at least, becomes very much smaller. The blood, coming in contact with the air and meeting the resistance of the narrowed vessel wall, begins to coagulate or clot, and soon a plug is formed which completely closes the end of the vessel and prevents any further escape of blood. The formation of this clot is also aided by the action of the heart, which, as a result of the hemorrhage, becomes weaker, and the blood is propelled through the vessels with less force. Thus a condition of the circulation is produced which not only favors clotting of the blood but also prevents the clot being immediately washed away as it forms. Later the clot becomes organized and forms a permanent plug of the vessel.

Means of Controlling Hemorrhage.—The surest method of stopping a hemorrhage is to catch the vessel up with a pair of forceps and tie it. In emergency cases, however, this is impossible as a rule, and our aim should be to temporarily control the hemorrhage until more thorough treatment can be pursued.

Hemorrhage may be controlled by (1) pressure; (2) position; (3) heat or cold (4) styptics; (5) torsion; (6) ligation.

(1) **Pressure** stands first and foremost as a temporary means of stopping hemorrhage. It may be applied by the finger, by compresses, by tourniquets, and by constricting bands. It

should be remembered that if the hemorrhage is from an artery, the pressure must be applied at some point between the wound and the heart; if the bleeding is from a vein, the pressure must be applied on the side of the wound farthest from the heart.

Digital pressure, usually effected by the thumb, may be applied directly to the bleeding vessel or at some point along its course. It should be applied in such a manner as to include the vessel between the finger and some bony part. Digital pressure can only serve for a short time, as the fingers soon become tired.

Fig. 136.—Method of making digital compression of an artery.

Pressure by Means of Compresses may be effected as follows: A number of small pieces of gauze or linen, or a tampon, previously rendered sterile or antiseptic, are placed in the wound one on top of the other until there are a sufficient number to compress the bleeding vessel. A bandage is then firmly applied to hold them in place and exert the necessary pressure. Sometimes more effective pressure can be obtained by employing a compress of gradually increasing size. Several small pieces of linen or gauze of about the size of a cent are first laid upon the point at which the compression is to be made, and upon these are placed larger pieces, thus forming a cone-shape compress, as shown in Fig. 137. Compresses may be applied in the same manner along the course of the vessel.

Fig. 137.—The action of a graduated compress upon an artery (Senn).

Pressure by Means of Tourniquets or Constricting Bands is a most useful method of controlling hemorrhage, but has the disadvantage that if prolonged for any length of time it is apt to be painful and may produce severe damage to the tissues.

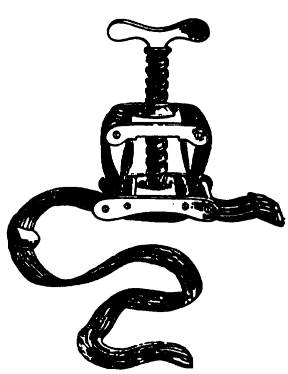

Fig. 138.—Petit's tourniquet.

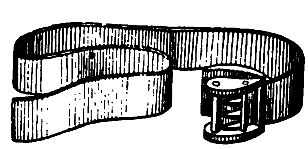

Fig. 139.—The field tourniquet.

There are various kinds of tourniquets, of which Esmarch's tourniquet, Petit's tourniquet, and the field tourniquet are examples. The manner in which they are applied may readily be understood from the accompanying illustrations. In an emergency, a tourniquet can easily be improvised which will serve all practical purposes. All that is needed is some strong material, like a towel, a belt, a rope, a bandage, or a handkerchief to encircle the limb, some round, hard body, such as a stone, cork, or piece of wood to act as a compress, and a short stick to tighten the tourniquet. Take the handkerchief or towel,

Fig. 140.—The application of the field tourniquet.

and, after folding it in the form of a cravat, place in its center the compress and tie it loosely around the limb in such a manner that the compress will be directly over the course of the bleeding artery. A stick is then placed through the loop on the opposite side of the limb and is twisted around until the tourni-

Figs. 141, 142.—Improvised tourniquets made with a handkerchief and stick (Stoney).

quet is tightened and the compress, acting on the vessel, stops the hemorrhage.

In controlling hemorrhage by simply constricting a limb, a piece of rubber tubing or a stout rubber band may be utilized.

The band is wrapped about the limb several times with sufficient tension to compress the bleeding vessel.

(2) **Position.**—Much may be accomplished in arresting hemorrhage from a small vessel by simply elevating the part, and even when the hemorrhage is from a large vessel it is useful if employed in conjunction with pressure or other methods. Sometimes bleeding from an extremity may be controlled by forcibly flexing the joint just above the seat of the hemorrhage, thus bending the vessel upon itself. This is more

Fig. 143.—Elastic constriction of thigh (Senn).

efficacious, however, if a compress or pad be first placed in the fold of the joint; the limb is then flexed and held in this position by a bandage (Fig. 144).

(3) **Heat and Cold** control hemorrhage by producing a contraction of the vessel wall and coagulation of the blood. They act best in capillary hemorrhage or hemorrhage from a very small vessel. Cold may be applied in the form of ice, ice-water, or snow. Heat may be applied by means of cloths wrung out in very hot water. Heat, however, is useless unless employed at a high temperature (120° to 140°). Warm water simply pro-

duces a dilatation of the vessels, increasing instead of arresting a hemorrhage.

(4) **Styptics** are substances which arrest hemorrhage by producing coagulation of the blood or contraction of the vessel wall; they must be brought into actual contact with the bleeding vessel to have any effect, and are only employed in arresting hemorrhage from regions inaccessible to other forms of treatment, as they are apt to soil a wound and thus frequently

Fig. 144.—Forced flexion of the elbow.

interfere with its healing. The principal styptics are alum, tannic and gallic acid, suprarenal extract, antipyrin, persulphate of iron, alcohol, and turpentine.

(5) **Torsion** consists in grasping the end of a vessel with a forceps or an artery clamp and twisting it around until the hemorrhage ceases. It is unsafe to apply this method to large vessels.

(6) **Ligation** is the surest and safest method we have for permanently controlling hemorrhage. Ligatures of catgut or silk, thoroughly sterilized, may be used. Ligation of a vessel is very easily accomplished provided the necessary instruments are at hand. The vessel is simply caught up in a pair of forceps, and a ligature placed around it and firmly tied. In the case of a divided artery, both ends of the vessel should be found and tied.

Twisting and tying, however, are unsafe methods to be employed by one unskilled in surgery.

Treatment of Hemorrhage.—The indications are, first, to stop the bleeding and then treat the shock or collapse which commonly results.

(1) **The Immediate Treatment of Arterial Hemorrhage.**—Arterial hemorrhage is the most dangerous form of bleeding with which we have to deal. The blood is flowing directly from the heart, and promptness in treatment is of prime importance. Do not wait for compresses or a tourniquet. Remember, we always have *in our hands* a most efficient means of controlling hemorrhage. Compress the bleeding vessel at some point between the wound and the heart, or, if the location of the bleeding artery is not known, simply tie a bandage or rope tightly around the limb above the injury. With the bleeding once under control, we can then take our time and direct some one how to prepare and apply a tourniquet or compress. Finally, a clean pad or compress should be applied to the wound, and the patient kept absolutely quiet with the part elevated until the arrival of medical assistance.

(2) **The Immediate Treatment of Venous Hemorrhage.**—In this form of hemorrhage the blood is flowing toward the heart, so apply pressure on the side of the wound farthest from the heart, being careful to remove any constriction from between the wound and the heart. The application of a compress to the wound is usually sufficient to stop the hemorrhage.

(3) **The Immediate Treatment of Capillary Hemorrhage.**—As a rule, simply exposure to the air or the application of heat

or cold will suffice to stop the bleeding. If not, a compress and bandage applied to the wound is all that is necessary.

(4) **The Constitutional Treatment of Hemorrhage.** — It should not be supposed that after we have stopped a hemorrhage we have done all that is necessary. Frequently, following a severe hemorrhage, the patient suffers from serious shock and is in such a state of collapse that only the most energetic measures will save his life. In the absence of a physician, have the patient immediately put to bed, with the head lowered, and the body covered warmly with blankets. Apply heat to the heart and extremities, *but do not give any stimulants*, as they may start up a fresh hemorrhage. In some cases it may be necessary to employ artificial respiration (see Artificial Respiration, page 257). In cases of great loss of blood, large quantities of saline solution should be given in an enema by the rectum. When the patient is almost exsanguinated or fatally exhausted from loss of blood, bandages may be applied to the extremities for the purpose of driving what little blood they may contain to the vital organs.

CONTROL OF HEMORRHAGE FROM SPECIAL REGIONS.

Hemorrhage from the Scalp can usually be controlled by compression at the seat of injury against the skull. If the bleeding be profuse, we may temporarily employ digital pressure over one or both temporal arteries (Fig. 146). They can be felt pulsating just in front of the ears.

Hemorrhage from the Face.—The face is supplied by the facial artery, which passes upward from the neck, crossing the lower jaw about half way between the ear and the chin, and supplies the lips and nose. It may be felt pulsating as it crosses the lower jaw and can readily be compressed in this locality (Fig. 147). Bleeding from the lips may be controlled by grasping them between the thumb and forefinger and exerting pressure.

Hemorrhage from the Neck.—The neck is supplied by the carotid arteries. They pass upward in a course indicated

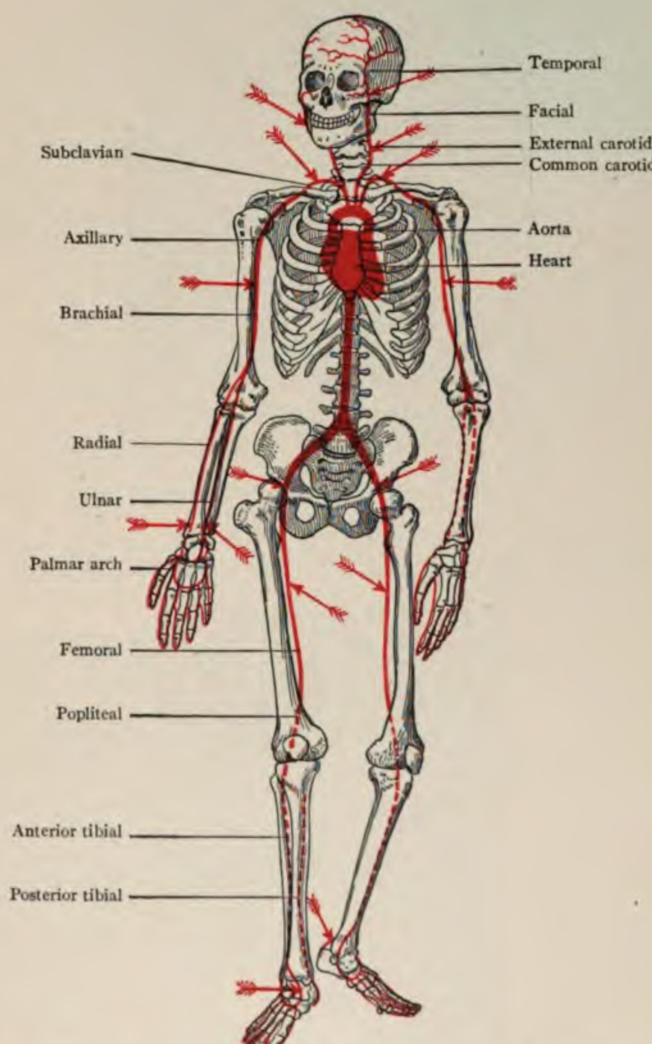

Fig. 145.—The relation of the principal arteries to the bones and joints. The arrows indicate the points where pressure may best be applied.

by a line extending from the junction of the clavicle and ster-

Fig. 146.—Compression of the temporal artery.

num to a point a little behind the angle of the jaw. The vessel may be compressed between the finger and the spinal column,

Fig. 147.—Compression of the facial artery.

but *never apply a tourniquet to the neck*, as such a procedure would strangle the individual. The carotid artery may be wounded in cases of attempted suicide by cutting the throat; if so, the injury is usually on the left side.

Fig. 148.—Compression of the carotid artery.

Hemorrhage from the Shoulder.—Pressure should be applied to the subclavian artery. It is usually difficult to locate; but in thin persons it may be felt pulsating behind the middle of the collar-bone. It may be compressed here between the thumb and first rib; or, as is sometimes done, a key padded as shown in the accompanying illustration (Fig. 150) may be substituted for the thumb.

Hemorrhage from the Armpit.—The armpit, or axilla, is supplied by the axillary artery, a continuation of the subclavian. Hemorrhage from wounds in this region may be controlled by placing a pad in the axilla and binding the arm tightly to the side. If this fails, pressure should be applied to the subclavian artery.

Fig. 149.—Compression of the subclavian artery.

Hemorrhage from the Arm.—The arm is supplied by the brachial artery, a continuation of the axillary. It runs down on the inner side of the arm from the junction of the outer and middle third of the axilla to the center of the bend of the elbow. It can readily be felt pulsating just internal to the biceps muscle; pressure may be applied here by the fingers or tourniquet.

Fig. 150.—Handle of door-key, padded (Da Costa).

Hemorrhage from the Forearm.—The forearm is supplied by the radial and ulnar arteries, which are branches of the brachial artery given off just below the bend of the elbow. The radial artery passes down the outer side of the forearm, and can be felt at the wrist as the radial pulse. The ulnar artery passes down the inner side of the arm and can only be felt with difficulty at the wrist, as at this point it is covered by tendons. Both vessels lie deeply imbedded in the muscles of the forearm in the upper portion of their course. Bleeding from the forearm may best be controlled by compression of the brachial artery at some point in the arm; or a pad may be placed in the bend of the elbow and the forearm forcibly flexed on the arm (Fig. 144).

Fig. 151.—Compression of the brachial artery.

Hemorrhage from the Hand.—The hand is supplied by the terminal branches of the radial and ulnar arteries, which unite to form two palmar arches. It is one of these arches that is usually cut in deep wounds of the hand. Bleeding from the hand can be controlled by pressure upon the brachial artery in the arm or at the elbow, or by compression of the radial and ulnar arteries just above the wrist. In hemorrhage from the palm, place a large, firm compress in the palm, have the fingers *very tightly* closed over it, and bandage them in place.

Hemorrhage from the Thigh.—The thigh is supplied by the femoral artery, which passes downward on a line extending from the middle of the groin to the inner side of the knee. It is quite superficial in the upper part of its course, and may be compressed here by the fingers, by a tourniquet, or by the forcible flexion of the thigh upon the abdomen. In the lower part of its course, the artery passes to the back of the thigh and knee, and is then known as the popliteal artery. It may be compressed in this region by placing a pad or compress behind the knee-joint and forcibly flexing the leg on the thigh (Fig. 154).

Fig. 152.—Compression of the radial and ulnar arteries at the wrist.

Hemorrhage from the Leg.—The leg is supplied by the anterior tibial artery, which passes down the front and outer side of the leg, and by the posterior tibial artery, which passes down the back of the leg. Both of these vessels are branches of the popliteal artery and both lie deeply in the upper part of their course, but approach the surface as they near the ankle-joint. Compression should be applied to the femoral artery or to the popliteal artery at the knee.

Hemorrhage from the Foot.—The foot is supplied by two plantar arteries, which are branches of the posterior tibial artery. Bleeding from the dorsal surface of the foot may be controlled by compression of the anterior tibial artery at the instep. In bleeding from the sole of the foot, compression may be applied to the posterior tibial artery just behind the internal malleolus.

Fig. 153.—Compression of the femoral artery.

THE TREATMENT OF SPECIAL FORMS OF HEMORRHAGE.

Hemorrhage from the Nose (Epistaxis).—As a rule, bleeding from the nose is slight and soon stops of its own accord. If the bleeding is persistent, have the patient remain quiet; remove the collar or any constriction from the neck; apply cold or ice to the back of the neck, and at the same time compress the nostrils between the thumb and forefinger. A solution of strong tea, alum, antipyrin, or suprarenal extract injected or snuffed into the nose will often stop the

Fig. 154.—Forced flexion of the knee.

bleeding by causing a clot to form. Should these measures fail, the bleeding nostril will have to be packed. This can readily be done by taking any soft material—cotton, linen, or lint—and gently forcing it well back into the nose. If the bleeding still continues, we may be sure it comes from some point behind or deep in the nose, and for such a case medical assistance should be obtained.

Hemorrhage After Extraction of a Tooth.—At times persistent bleeding may follow the extraction of a tooth, but the application of ice, or a plug placed in the cavity and held there by the closed jaws, will usually suffice to stop it. Should this fail, pack the cavity tightly with cotton or linen saturated in a solution of alum, strong tea, or some other styptic; then have the jaws closed, and apply a Barton's or four-tailed bandage to hold them in position.

Fig. 155.—Varicose veins (Burrell).

Hemorrhage from Varicose Veins.—The term varicose veins is applied to a dilated condition of the veins, usually due to a weakened vessel wall or to causes that interfere with the circulation in the veins, such as the wearing of tight clothing. It is a condition that may occur in any locality, but is generally seen in the veins of the legs. Rupture of one of these dilated veins is very apt to occur and may result in a profuse hemorrhage. Elevation of the part and the application of a compress to the wound will generally be all that is required.

Following such an accident, the patient should be kept absolutely quiet and flat on the back.

Internal Hemorrhage.—Internal hemorrhage, also spoken of as concealed hemorrhage, may occur in any of the cavities and from any of the organs of the body as the result of injury or disease. It is a condition which may be very difficult to diagnose, as the hemorrhage cannot be seen, and we frequently have only the symptoms of shock. In such cases procure the services of a physician immediately; in the meantime, put the patient to bed and keep him absolutely quiet.

Hemorrhage from the Lung (Hemoptysis) may result from wounds of the lung, but is more often due to a diseased condition of that organ. The patient is seized with a fit of coughing, and spits up bright red, frothy blood. Unfortunately, nothing can be done to directly control the hemorrhage. The treatment, in the absence of a physician, consists in absolute quiet, rest in bed in the recumbent position, and the use of ice by the mouth. *Avoid the use of stimulants.*

Hemorrhage from the Stomach (Hematemesis) is due to an injury or a diseased condition of the vessels of the stomach wall. The patient has a sense or feeling of fullness in the region of the stomach, perhaps accompanied by some pain which is soon followed by the vomiting of dark, clotted blood, often described as resembling "coffee grounds." It should be remembered that vomiting of blood is not always a sign of hemorrhage from the stomach; the vomited blood may have originally come from the mouth or nose and have been swallowed. In the absence of a physician, treat this condition by rest in bed and by giving ice in small quantities by the mouth, but *do not use stimulants* and *avoid giving any food for some time afterward.*

Consecutive and Secondary Hemorrhage.—Hemorrhage recurring within twenty-four hours after an injury is spoken of as a consecutive hemorrhage. If it comes on after the first twenty-four hours it is known as a secondary hemorrhage.

Recurrence of a hemorrhage may be due to the heart acting with such force as to wash away blood clots which have formed in the vessel, or it may be the result of sloughing of the vessels following infection. As a rule, elevation of the part and compression of the bleeding vessel generally suffice to stop the flow of blood. If this fails, apply a tourniquet. In gunshot wounds or, in fact, any wound where we might expect recurrence of the hemorrhage, it is well to have a tourniquet loosely applied to the part, so that it may be tightened immediately if required. Where the hemorrhage is the result of infection, it will be necessary to clean out the wound and secure the vessel by ligation at some point higher up.

CHAPTER XIII.

INFLAMMATION, CONTUSIONS, AND WOUNDS.

INFLAMMATION.

The terms *inflammation*, *suppuration*, *gangrene*, and *sloughing* will be used frequently in the following pages, and it is essential that they be thoroughly understood. The subject of inflammation is very broad, embracing many diseases which require medical as well as surgical treatment, but can hardly be considered with such conditions as hemorrhage, wounds, etc., which may require immediate and prompt attention to save the individual's life. Only a brief explanation of the subject will be given here without going into the treatment at all.

Inflammation may be defined as the reaction of the living tissues of the body against harmful influences; in other words, it is simply the protest of the tissues against an irritation or injury which is manifested by a series of successive changes producing redness, heat, pain, swelling, and loss of function in the injured part.

The causes of inflammation are wounds, contusions, fractures, foreign bodies, long continued pressure, friction, heat, cold, acids, caustics, and bacteria,—in fact, any influence severe enough to disturb or injure the tissues.

The Phenomena of Inflammation.—When the tissues are irritated from any of these causes there occurs first a dilatation of the small vessels and capillaries, producing an increased supply of blood to the part or a condition of congestion, and the part becomes *red* and *hot*. The vessels continue to dilate and become so distended that they press upon the sensory nerves, causing acute *pain* which is increased with each beat of the heart. This explains why we so often feel a throbbing sensation in an inflamed region. The circulation next becomes very much slower, and, if the inflammation is severe enough, complete stoppage occurs. The leukocytes (white cells of the blood), in the meantime, separate from the other elements of the blood and range along the walls of the blood-vessels, and, as the circulation becomes slower, they cling there and, if not swept away, will pass through the walls of the vessel into the surrounding tissues. This they do through the property of ameboid movement. When the circulation becomes very slow or stops, the red cells and other elements of the blood may likewise pass into the neighboring tissues. After leaving the vessels the leukocytes make their way to the point of injury and surround any foreign bodies or bacteria that may be there. Thus, a collection of cells, spoken of as *exudate,* forms in the tissues adjacent to the seat of injury, and there results a *swelling* of the injured part. These successive changes take place when the skin becomes inflamed (dermatitis); when the peritoneum is inflamed (peritonitis); when the appendix is inflamed (appendicitis); or in any other tissues of the body which may be the seat of inflammation.

As the result of an inflammation one of three processes may take place,—namely, the tissues may gradually return to a normal condition, suppuration may occur, or the inflammation may terminate in gangrene or death of the tissues.

Resolution.—The return of inflamed tissues to a normal condition is termed *resolution;* the circulation becomes reëstablished, the vessels contract, the white cells return to the blood, and the exudate is gradually absorbed. With this return to a normal condition pain, redness, and heat disappear, and the swelling slowly subsides.

Suppuration is a condition which occurs in inflamed tissues through the entrance of bacteria. They produce a softening of the exudate already there and the death of many of the leukocytes, so that the exudate becomes a creamy looking liquid, full of bacteria and dead or dying leukocytes, known as *pus.* Suppuration may result in the diffusion of pus through the connective-tissue spaces, or it may produce a distinct cavity in the tissues filled with pus, known as an *abscess*.

Gangrene, or mortification, is the death of tissues. The part that dies is called the *slough*, and the condition itself is often simply spoken of as *sloughing*. When bone dies, the condition is called *necrosis*. Anything which causes a stoppage of the circulation for any length of time will produce gangrene. In inflammation this may be brought about from compression of the vessels by the exudate, by the growth of bacteria, or by the coagulation of the blood in the vessels as the result of the inflammation. Depending upon the suddenness with which the blood supply of a part is shut off, moist or dry gangrene may result.

Moist Gangrene is the result of a sudden stoppage of the circulation, as occurs, for example, sometimes after ligation of the main artery to a part. It may also occur from the immediate destruction of the vitality of the tissues following extensive lacerations or contusions.

Dry or *Senile Gangrene* is produced by a gradual diminution of the supply of blood. It is usually seen in old people as the result of a weak heart or diseased blood-vessels.

As an example of inflammation and suppuration a simple *boil* or *furuncle* may be taken,—the suppuration occurring in one of the hair follicles or sebaceous glands of the skin. A *carbuncle* is a more severe form of suppuration accompanied by sloughing. A *bed-sore* is simply gangrene resulting from pressure, the circulation of the part usually being poor to begin with. The same condition may be produced by long-continued pressure from poorly padded splints.

CONTUSIONS.

A contusion, commonly called a bruise, is a crushing of the tissues usually without any breaking of the skin. Contusions are caused by blows from blunt instruments or follow compression produced by heavy forces.

They are characterized by swelling, tenderness, and a discoloration due to an escape of blood into the tissues as the result of the rupture of small vessels in the neighborhood of the injury. At first the discoloration is red, then blue or black, and finally turns yellow or green. A severe contusion may result in rupture of one of the large vessels, causing a subcutaneous hemorrhage or collection of blood in the tissues known as a *hematoma*. In such cases the contused area is very liable to become infected through the skin and an abscess may result. The pain in a contusion is ordinarily dull or aching and rarely lasts long. Shock, however, is frequently present in the more severe forms.

Treatment.—We should remember that following a severe contusion the vitality of the tissues is much impaired, and a good soil is present for infection; hence, the injury should be treated with some care. The skin over the contused area should be first gently but thoroughly scrubbed with soap and water, followed by the use of some antiseptic solution. If any small cuts or abrasions be present, keep them covered with a piece of clean cotton or gauze.

Of local applications for the relief of pain and the reduction of swelling, cold is the best in the early stages. It may be applied by means of cloths wrung out in ice water and frequently changed, or by the use of the ice-bag or ice-cap. The use of cold should be avoided if the contusion is a very severe one or if the injury is in an old person, as in such cases the tissues have but little vitality, and the prolonged application of cold may be followed by a destruction of the tissues, or even gangrene. In these cases hot applications will be better. Both heat and cold are more efficacious if they are accompanied by the use of moderate pressure applied directly to the injured part. Pressure prevents the further escape of blood and also assists in the absorption of that already present. Other remedies that act well and are frequently found to relieve pain include many astringent solutions, such as lead-water and laudanum, aluminum acetate, dilute alcohol, dilute vinegar, etc.

In addition, the contused part should, if possible, be elevated and put at rest,—elevation helps to prevent the escape of blood into the tissues, and rest is important from the fact that any unnecessary movements of the part are not only painful to the sufferer, but are also liable to add to the damage already present. Rest of the injured part may be secured by the use of bandages or, if the extremities are affected, by means of slings or splints. Later, when all inflammation has subsided, massage is useful in aiding in the absorption of the effused blood and in restoring the function of the part.

Black Eye.—A black eye is simply a form of contusion, but on account of the resulting discoloration and the disfigurement which is apt to occur it is a very troublesome form of injury.

Treatment.—When discoloration has appeared but little can be done to remove it; but, if seen early enough, judicious treatment will do much in preventing or at least limiting its development. Hot or cold applications to the eye with firm pressure immediately after injury are the best remedies. Raw meat is also frequently used. Later, absorption of the blood may be hastened by gentle massage.

WOUNDS.

A wound is a break or a division of the continuity of the tissues usually produced by sudden force.

All wounds are accompanied by one or all of the following signs or symptoms: pain, hemorrhage, loss of function, and retraction of the cut edges, while if the injury is very severe, there is produced, in addition, a general condition of depression affecting the vital functions known as *shock*.

The Repair of Wounds.—When tissues are cut, the edges always retract, there is more or less hemorrhage, and the space between the cut edges becomes filled with a blood-clot. Where the edges of the wound are brought into apposition, and unless there is some infection present, only a slight inflammation occurs as a result of the violence to the tissues, shown by some little redness, swelling, and pain about the cut edges. This rapidly subsides, however, and the skin, connective tissue, and whatever tissues may be cut, send out new cells similar to those of which they are composed to repair the damage. These cells enter the blood-clot and form new tissue; at the same time, small buds or loops will be seen springing from the cut capillaries and vessels, which permeate the blood-clot and mass of new cells and form blood-vessels for this new tissue. This is called healing by first intention or apposition.

Should the edges of a cut be allowed to gape open, or should there be a considerable loss of tissue at the time of injury, or suppuration of the wound result, healing occurs by second intention or granulation. The same steps occur as in healing by first intention, the only difference being in the amount of new tissue to be formed. There is a blood-clot formed, a pouring out of new cells, and the appearance of new blood-vessels; in addition small red elevations, known as granulations or more commonly as "proud flesh," appear on the surface of the new tissue, gradually filling up the gap between the divided edges of the wound as the new tissue forms from below. When the level of the divided surface is reached, cells grow out from the edges over the granulating surface, and thus the repair is effected, The new-formed tissue is now known as a "scar" or cicatrix. It is at first red or pink and of the same extent as the wounded surface; later it becomes white, and through contractions its area is diminished.

The General Treatment of Wounds.—The indications are to arrest hemorrhage, to combat shock if present, to clean the wound, and finally to apply an occlusive dressing.

The Arrest of Hemorrhage.—The various means at our disposal for stopping hemorrhage have been described in the chapter on that subject. Remember that we can control the bleeding temporarily by the use of pressure, a compress, or a tourniquet, but later the bleeding vessel, if a large one, should be caught up and tied.

The Treatment of Shock.—Endeavor to bring about reaction slowly by the use of heat applied to the heart and extremities. Place the patient prone, with the head low, and cover up warmly with blankets. Avoid the use of stimulants, or use only with precaution. (For further treatment see page 275.)

To Clean the Wound.—All wounds should be thoroughly cleaned before they are dressed. Remember to clean the hands before handling a wound and to bring nothing in contact with the wounded surfaces which is not sterile, or at least clean. If there is much hair about the part, it should be removed by cutting or shaving,—say for a distance of several inches from the cut edges. Then wash the skin with soap and water, and follow by the use of some antiseptic solution, as a solution of corrosive sublimate (1 : 1000) or carbolic acid (1 : 100). Be careful to avoid rough handling of the wounded surfaces, as such treatment only adds to the severity of the injury and often delays union.

Some wounds, especially lacerated wounds, will be fairly ground in with dirt and grease, so that it would seem impossible to clean them. In such cases the use of a little turpentine will aid greatly in cleaning the part by dissolving the grease. All pieces of glass, splinters, portions of clothing, or other foreign bodies which may have become imbedded in the tissues, should be removed, even if it is necessary to enlarge the wound to do so. Always examine a wound for such foreign matter before dressing, and, in *scalp wounds especially, make a careful examination for fracture of the skull.*

To Dress the Wound.—If a physician is near, a temporary dressing only need be applied. Such a dressing aims to protect the wound from the air and prevent the entrance of germs. With this end in view simply cover the wound, without handling it, with a piece of gauze, linen, or lint, and apply a bandage.

In the absence of medical assistance, some attempt should be made to bring the edges of the wound together. Of course the use of sutures is the best means for accomplishing this, but as a substitute, strips of plaster may be employed. For sutures, catgut, if available, is the most convenient, as it will not have to be removed. Employ for ordinary wounds the interrupted stitch and tie the sutures with a reef-knot. Silk sutures, if used, may be removed in six or seven days. Narrow strips of plaster

—say one-quarter to one-half inch wide—may be used as sutures if applied at intervals across the edges of the wound in sufficient number to hold the cut surfaces in apposition. Plaster strips should never completely encircle the limb, as they then act as constricting bands, interfering with the circulation. Care should be observed, in removing the plaster, to pull it off from both ends toward the wound, so as not to pull the wound open. (For the application of adhesive plaster as sutures, see also page 147.)

As a rule the edges of large, deep wounds should not be too tightly apposed. Some chance of escape should be left for the serum and secretions which are sure to be present,—in other words, means of drainage should be supplied. This may be effected by the use of small pieces of rubber tubing, strands of catgut or silkworm-gut, or a small strip of gauze placed in the lower angle of the wound. Wounds which are dirty or already infected should always be drained.

For clean wounds it is preferable to use dry sterilized or antiseptic gauze as an occlusive dressing, but in their absence clean linen or lint soaked in some antiseptic solution will answer the purpose.

Wounds which are infected or from which there is much discharge are best treated with a wet antiseptic dressing,—that is, a dressing kept saturated with some antiseptic solution and covered with oil-silk or rubber tissue to retain the moisture. It is well to surround the whole dressing with an abundance of cotton or gauze to absorb discharges. Such dressings should be frequently renewed.

Finally, the injured part should be given as complete a rest as possible, so that healing may go on undisturbed. In cases where the extremities are wounded, slings or splints should be applied for this purpose.

SPECIAL FORMS OF WOUNDS.

Wounds are classified as incised, lacerated, contused, punctured, gunshot, or poisoned.

Incised Wounds are produced by some sharp cutting instrument, such as a knife, a sword, or a piece of glass, the tissues being cleanly divided without any bruising or tearing. They are accompanied by a sharp burning pain due to injuries to the terminal nerves. They are apt to gape widely, and, as a rule, bleed freely. Especially is this so if the wound is situated upon the face, scalp, or hands, where there is a liberal supply of blood-vessels.

Treatment.—The general rules for the treatment of wounds should be followed. If the wound is clean simply bring the cut edges together by the use of strips of plaster or by sutures and dress with antiseptic or sterile gauze. Incised wounds about the wrist are frequently complicated by the division of some of the tendons or nerves. If such be the case, the divided ends must be sought for and united with sutures. Should this be neglected the hand may be rendered useless. An incised wound, if clean, should heal in from seven to ten days.

Lacerated Wounds are the result of a tearing of the skin and tissues by blunt instruments or machinery. They present ragged edges, which do not retract much, and which, as a rule, consist of masses of torn tissue, frequently ground in with dirt. The pain in a lacerated wound is dull or aching in character; the hemorrhage is slight owing to the twisting and tearing to which the ends of the injured vessels are subjected. There is usually an excessive amount of shock with this form of injury; and, owing to the extensive tearing of the tissues, infection, sloughing, and secondary hemorrhage are liable to occur.

Treatment.—Lacerated wounds are very prone to infection, and should always be thoroughly cleaned. Be careful to remove all dirt and dead tissue. Large torn vessels, whether they are bleeding at the time or not, should be tied. As a rule no attempt need be made to approximate the edges of the wound. It is better to leave it open and allow discharges and secretions to escape. If, however, the wound is an extensive one, the edges may be loosely drawn together by one or two sutures or strips of adhesive plaster, provided room is left for free drainage. Shock will also require appropriate treatment.

Contused Wounds are those in which the division of tissues is accompanied by a more or less severe crushing. Such wounds are caused by heavy blunt forces. External hemorrhage is, as a rule, slight, but there may be considerable bleeding into the surrounding tissues. Breaking down of the blood-clot and sloughing are liable to occur later.

Treatment.—Treat by the same methods employed for lacerated wounds. Where there is much tension from effused blood, it is well to make a small opening and remove the clots. Then protect with an antiseptic dressing.

Punctured Wounds are produced by thrusts from pointed instruments, and sometimes from needles, thorns, pieces of glass, splinters of wood, steel, etc. They are generally small in size, but may be of great depth. When caused by small, smooth, clean instruments they are usually trivial; but, if produced by splinters or by instruments which we have reason to believe are dirty, they become dangerous on account of the liability to infection. Pain in punctured wounds is slight, nor is hemorrhage severe as a rule.

Treatment.—When produced by a clean instrument, simply apply an occlusive dressing, first having disinfected the skin. Dirty wounds should be swabbed out with pure carbolic acid and drained. Then dress antiseptically. In all cases any foreign bodies should always be removed.

A splinter should be pulled out straight, care being taken not to break it off. Sometimes splinters imbedded in an extremity, as a toe or finger, may be removed by tightly wrapping a piece of rubber band about the part from below up to the point where the splinter is located. This serves to depress the tissues from the splinter, the end of which will thus be made to project above the skin sufficiently to be lifted out with a sharp-pointed knife.

Gunshot Wounds.—Under this head are included wounds produced by rifle and pistol balls, small shot, and shell.

In gunshot wounds there is a wound of entrance and usually one of exit, but there may be only one wound, or the same bullet may produce several wounds. These wounds are always accompanied by more or less contusion and laceration of the tissues, depending on the kind of missile producing the injury. This destruction of tissues, known as the "explosive effect," is situated mostly at the point of entrance of the missile and is caused by the bullet's sudden impact and rotation in the tissues. Its severity depends on the velocity of the bullet. The old-fashioned guns produced this effect only at a short range, but modern rifles can produce it at a distance of five hundred yards or more. Bullet wounds are dangerous from the fact that they are liable to infection, especially if portions of the clothing have been carried into the wound with the bullet, while the condition of contusion about the margins of the wound renders sloughing very probable.

Fig. 156.—Upper end of tibia penetrated by bullet, showing cleancut wound without laceration of bone (La Garde).

While the bullets fired from the old guns were frequently deflected by bone or tendons after entering the tissues, this rarely happens with modern firearms. Owing to their greater velocity, bone is penetrated with ease. Modern bullets, however, produce less damage when they do penetrate bone than did the old-style bullet. The former simply produce a small, clean hole, whereas the latter caused great damage, frequently producing an extensive splintering and bad comminuted fractures.

Wounds from small shot vary as to severity according to the ranges from which they are fired. At long range they rarely do more than penetrate the skin; at close range they enter the body as a solid mass causing a destruction of tissues which is often irreparable. Single shot are easily deflected and rarely penetrate bone.

Wounds from large shot or shell are characterized by an extensive tearing of the tissues.

Gunshot wounds are accompanied by the usual symptoms of other wounds. Pain is generally slight and at first may not

Fig. 157.—X-ray showing the effect of bird-shot. (Kindness of Dr. G. D. Stewart.)

be noticed at all. Hemorrhage may be profuse at first, but usually ceases spontaneously unless some large vessel is divided. Shock is generally present, especially if there is much laceration of tissues. Secondary hemorrhage is very liable to occur on account of the contusion of vessels and subsequent sloughing.

Treatment.—The immediate treatment of gunshot wounds consists first in arresting hemorrhage. Having done this, apply a temporary dressing and bandage the wound firmly, then immobilize the part by the use of a sling or splints and have the patient removed to a hospital, or put under the care of a surgeon for proper treatment. In the absence of medical assistance, *never probe a bullet wound*, as nothing is to be gained by such a procedure, and much damage may be done by carrying infective material into the wound.

The later treatment of a simple bullet wound would consist in thoroughly cleaning the wound and applying an antiseptic dressing. Should any foreign matter have been driven into the tissues, the wound will have to be enlarged sufficiently for its removal, first having sterilized the surrounding skin. Splinters of bone may be removed in the same way. Finally, irrigate the wound with an antiseptic solution and pack with sterile or antiseptic gauze. Bullets may be removed at once when they can be felt beneath the skin or when they are likely to interfere with the healing of the parts; otherwise, it is far better to wait until the wound has healed and remove later.

In wounds from small shot where the pellets are simply imbedded in the skin, clean the skin thoroughly and remove the shot by picking them out with the point of a knife. If they are in the deeper tissues it is best to leave them alone, unless they give trouble. Extensive wounds of the extremities from small shot or shell, producing severe injury to the tissues and bones, usually require amputation of the part.

Wounds from Toy Pistols.—These injuries are unfortunately of quite common occurrence as the result of the explosion of cheap pistols and revolvers. Any number of these wounds are met with in enthusiastic small boys around the Fourth of July. They are especially dangerous from the fact that they are often neglected, and lockjaw (tetanus) is very liable to follow.

Treatment.—In the absence of a physician, cleanse the wound *very thoroughly* and examine it closely for the presence of any foreign bodies. Portions of wadding will sometimes be driven into the tissues quite a distance and can only be removed by cutting away the skin; but no matter how deeply situated, all foreign matters should be removed. Then irrigate the wound and dress antiseptically. Such wounds should be washed out with peroxide of hydrogen, if it can be obtained.

Powder Burns are due to the explosion of gunpowder or fireworks. They simply consist of particles of powder which have been driven into the skin, giving it a blackened appearance. They are dangerous if situated about the face, as they may cause injury to the eyes.

Treatment.—Wash the skin clean and pick out all the particles of powder with a needle or sharp-pointed knife. Then apply a clean dressing to the part.

Arrow Wounds are rarely seen in civilized countries. They are apt to be dangerous as the shaft of the arrow frequently breaks off, the arrow point remaining imbedded in the tissues.

Treatment.—If possible, remove by gently pulling on the arrow; or, when near the surface, it may be pushed on out through the sound skin. Failing in these measures, enlarge the wound and remove. Afterward irrigate the wound thoroughly and dress antiseptically.

Wounds from Fish-hooks.—While the wound itself is not serious, it is a painful injury, and some difficulty may be experienced in removing the hook. The best way to accomplish this is to press the hook on out through the tissues until the barbed end is in view, when it may be cut or broken off, and the hook withdrawn.

Sword Wounds are generally of the nature of incised or punctured wounds and should be treated upon the principles already laid down.

Bayonet Wounds are to be treated as any punctured wound. They are dangerous, from the liability to infection.

Poisoned Wounds are those in which some poison is introduced into the tissues at the time the injury is inflicted. Dissecting wounds, stings of insects, snake bites, and the bites of rabid animals come under this head.

(1) **Dissecting Wounds** are met with in butchers, surgeons,

and those who perform post-mortem examinations. The poison usually enters through some cut or abrasion in the skin, and, if the individual is in poor health, such a wound is likely to be followed by serious complications.

Treatment.—As soon as inflicted the wound should be washed and then sucked or squeezed to get rid of the poison. Shut the wound off from the general circulation by tying about the injured part a tight ligature, which should be loosened at intervals; then thoroughly cleanse and apply iodine, iodoform, or some antiseptic solution to the wound.

(2) **Insect Bites.**—The stings of ants, bees, wasps, hornets, and yellow-jackets seldom produce any serious trouble, aside from the immediate pain and swelling. The bites of spiders, centipedes, tarantulas, and scorpions are more serious and have been known to result in death. Dangerous symptoms appear very quickly and are manifested by vomiting, purging, great prostration, and delirium. Death occurs from heart failure.

Treatment.—Ordinary insect bites require but little treatment. Sometimes the sting of a bee is broken off and remains in the skin; so always search for it and remove, if present. As the poison of insects is composed chiefly of an acid (formic acid), the local application of some alkali should be employed. Water of ammonia or a solution of washing soda affords great relief. Wet earth or a fresh slice of onion may also be used.

Bites of the more poisonous spiders and insects require prompt treatment. Tie a ligature about the injured part and suck the wound to produce bleeding. Then enlarge the bite with an incision and swab out with pure carbolic acid or some other antiseptic. Should dangerous symptoms appear, stimulate the patient freely with whiskey.

(3) **Snake Bites.**—The poisonous snakes of the United States are the water moccasin, copperhead, and rattlesnake; in Europe the viper; in India the cobra; in the West Indies the fer-de-lance; and in Venezuela the bushmaster. Besides these, there are many poisonous lizards, the gila monster being the only one to be feared in the United States.

The poison of these reptiles is secreted by a pair of glands situated on either side of the upper jaw. At the moment the bite is inflicted the poison is discharged through the hollow fangs by means of contractions of muscles acting on the poison bag.

Following such a bite, there is pain at the seat of injury which soon becomes excruciating, rapid swelling, and ecchymosis. The part takes on a purplish hue. There is at the same time a feeling of nausea and faintness, while a sense of depression takes hold of the individual. The pulse becomes rapid and feeble, and the breathing is labored. In fatal cases death may occur within twenty-four to forty-eight hours.

Treatment must be instituted promptly. Prevent any further spread of the poison by placing a tight ligature about the part, encourage bleeding and the escape of the poison by sucking the wound, *provided, however, there are no cuts or abrasions upon the lips.* A ligature should not be put on tightly and left for any length of time, as this will entirely cut off the circulation to the part; it is better to loosen and tighten it at intervals, thereby letting only small quantities of the poison into the system at a time. Further treatment consists in cauterizing the wound. This may be done by means of a hot iron or a piece of a hot coal; gunpowder placed in a wound and ignited will also thoroughly cauterize it.

If constitutional symptoms appear, whiskey should be given in liberal quantities, and heart stimulants, if to be had, should be used. Injections of potassium permanganate into the wound are also very useful.

(4) **Bites of Animals,** unless the animal is afflicted with hydrophobia, are not serious, but the wounds may become infected, however, and cause considerable trouble.

Hydrophobia, or *rabies*, is the result of an infection of the system through a wound with the virus of a rabid animal. The disease is usually communicated to man by dogs, but cats, wolves, foxes, and horses are equally dangerous when affected. The incubation period is usually six weeks, but may be anywhere from a few days to years. It is said that 14 per cent. of those bitten by rabid animals develop the disease. If bitten through the clothing, there is less danger of inoculation than if the bite is on an exposed part of the body. When a person has been bitten by an animal supposed to have hydrophobia, but where there is some doubt, the animal should not be killed, but should be confined and carefully watched until it is certain whether it really had the disease. If it is found that it did not have the disease, the patient's mind will certainly be relieved.

Treatment.—The immediate treatment of the wound consists in destroying the poison and preventing its escape into the system. Place a ligature about the part and thoroughly cauterize the wound with the hot iron, hot coal, or some caustic. If this is not possible simply excise the whole wound with a sharp knife and dress antiseptically.

The later treatment consists in having the patient removed to a Pasteur institute for inoculation with preventative serum.

WOUNDS OF THE CHEST AND ABDOMEN.

Wounds in the cavities of the body are spoken of as *non-penetrating* when they do not extend entirely through the wall of the cavity; *penetrating*, where they enter a cavity; and *perforating*, when they penetrate and produce some injury to the viscera within. These injuries are usually the result of stab or gunshot wounds. Perforating wounds are most serious injuries, because they may be accompanied by wounding of the heart, lungs, intestines, or some of the other abdominal viscera, and frequently by injuries to some of the great vessels, which cause a fatal hemorrhage.

Injury to the heart and pericardium, if not immediately fatal, produces severe shock and internal hemorrhage.

Wounds of the lungs are manifested by pain, coughing, difficult breathing, and spitting up of blood and bloody mucus. There may also be a hissing sound of air escaping through the wound with each respiration.

Injury to the abdominal viscera is accompanied by great shock. There is a severe stabbing pain and profuse internal hemorrhage, soon followed by collapse. Wounds of the abdomen, even though moderate in extent, are liable to be followed by protrusion of the intestines. Gas, bile, and partly digested food frequently escape from the wound, depending upon the parts injured.

Treatment.—Always send for medical aid promptly. In the meantime, unfortunately, but little can be done except to clean the wound and cover with a clean compress or pad. Endeavor to keep the patient quiet and free from excitement. If the intestines or other viscera are protruding, they should be washed off in clean warm water, or salt and water, and replaced if uninjured; otherwise, endeavor to keep them warm and protected from the air until medical aid arrives by wrapping them in cloths wrung out in hot salt water and frequently changed. Treat the shock by external heat applied to the heart and extremities.

CHAPTER XIV.

BURNS, SCALDS, AND EXPOSURE TO COLD.

BURNS AND SCALDS.

A *burn* is an injury or destruction of the skin or deeper tissues caused by dry heat, heated substances, or chemical agents.

A *scald* is the same kind of an injury, but differs from a burn in being produced by hot vapors or hot liquids.

Burns and scalds so closely resemble each other that they will be considered together. A scald, being caused by liquids and substances which are easily diffused over a large area, usually covers more surface and is apt to be more superficial than a burn. The hair on a scalded surface usually remains uninjured, while in a burn it is scorched or completely burned off. Extensive burns or scalds, even when superficial, are dangerous; and, if one-half of the surface of the body is so injured, a fatal result is to be expected, even superficial burns involving one-third of the body often terminate fatally.

The pain following a burn or scald is intense and is increased by exposure of the part to the air. Shock is present to a more or less marked degree in all burns, the fatal cases usually terminating from shock within twenty-four hours. Extensive burns cause a congestion of the internal organs, and frequently the congestion is so intense that the sufferer shivers and complains of being cold. Should a patient survive the immediate shock and react, he is liable to die later from congestion of the kidneys, lungs, or brain.

Classification of Burns.—Burns are divided, according to the amount of tissue destroyed, into three degrees.

(1) *A burn of the first degree* is where a simple redness or inflammation of the skin is produced.

(2) *A burn of the second degree* is where there is inflammation of the skin accompanied by blebs or vesicles.

(3) *A burn of the third degree* is where there is a charring and destruction of the skin and deeper tissues.

Treatment.—In removing the clothing from the body of a badly burned person, care should be taken not to injure the blebs. The clothing is very apt to stick to the injured surfaces, and so should be cut or ripped up the seams, the portions which remain fast being softened with oil or warm water and then carefully removed.

For burns of the first degree a solution of bicarbonate of soda or carron oil, composed of equal parts of linseed oil and lime water, poured on lint, makes a soothing dressing. Vaseline, lard, cosmoline, boric acid ointment, zinc oxide ointment, olive oil, and castor oil, or even white paint may be used if nothing better is at hand.

In burns of the second and third degree, aside from the severity of the injury itself, one is impressed with the excessive amount of pain and severe shock which are usually present; and these symptoms should be *promptly treated*, the pain being controlled by the use of morphine. Any of the dressings recommended for burns of the first degree may be used; but, where there is much destruction of tissues or sloughing, a weak antiseptic dressing acts better. All the blebs should be punctured with a sterile needle or sharp-pointed knife, and the serum allowed to escape; but the skin of which these blebs are composed should not be removed, as it forms a protection from the air for the parts beneath. In dressing extensive burns care must be taken not to expose a large surface to the air at once. To avoid this it is well to apply the dressings in small sections, so portions may be removed and reapplied without disturbing the whole dressing. All sloughs and dead tissue should be cut away at each dressing.

To Extinguish Flames from a Person's Clothing.—It may be well to say here a few words about what to do when a person's clothing catches fire. It should be remembered that flames invariably rise upward; hence, if a person whose clothes are afire lies flat upon the floor or ground there will be less fuel for the flames and less surface of the body exposed than in the upright position. Most people forget this or become confused and panic-stricken and rush wildly about and, by so doing, simply furnish an added draught for the flames. Do not get excited yourself, but instruct the sufferer to lie down flat, or

Fig. 158.—Proper method of extinguishing flames from the clothing with a blanket.

even throw him down, if necessary, and quickly envelop the whole body with a blanket, rug, tablecloth, or coat, and attempt to smother the flames. In doing this, care should be taken to stand at the sufferer's head and, holding down with the foot one edge of the blanket or whatever is used, to throw it away from yourself and toward the feet of the individual; the flames are thus swept away from the rescuer and from the face of the burning person. Through carelessness in this matter the flames are liable to be swept back and set fire to the clothes of the rescuer, especially if such a person be a woman with skirts.

Burns from Acids are generally caused by concentrated nitric, hydrochloric, or sulphuric acid. They are frequently the result of acid-throwing assaults.

Treatment.—Neutralize the acid with some alkali, using for this purpose lime-water, a solution of washing soda, soap, or chalk; then treat as any burn. If the eyes are injured, wash them out with a weak solution of bicarbonate of soda and apply a few drops of oil between the lids.

Burns from Alkalies are usually produced by caustic soda, caustic potash, or lime.

Treatment.—Neutralize with some weak acid, as vinegar or lemon juice, and treat as you would an ordinary burn.

Brush Burn is a form of injury produced by friction. It is often caused by a rope rapidly passing through the hands, and is similar to a burn in appearance.

Treatment.—Clean the wounded surface and dress antiseptically; or treat as a burn.

Burns from Electricity and Lightning.—If the current is strong death usually occurs instantly, being due to asphyxia from a paralysis of respiration. In other cases the patient may be simply rendered unconscious and severely burned. The burns themselves are very severe, as they are followed by an extensive sloughing and destruction of tissues, and heal very slowly.

Great caution should be observed in approaching a person who has received an electric shock and is still in contact with the current. *Do not touch the body until the current has been turned off unless you are provided with rubber gloves*, as such a procedure would result in the rescuer receiving the full force of the current.

Treatment.—Send for medical aid immediately. In the meantime apply external heat and friction to the extremities.

If the respirations have ceased, employ artificial respiration. The burns may be treated as any ordinary burn.

Sunburn.—In some individuals exposure to the sun produces great redness of the skin and marked pain,—a condition similar to a burn of the first degree or even of the second degree. If a large area of the body is involved, death may ensue.

Treatment.—Apply any of the soothing applications recommended for burns of the first degree.

EXPOSURE TO COLD.

Prolonged exposure to extreme cold results in a general depression or lowering of the vitality, a gradual chilling of the body, and a congestion of the internal organs. The body and limbs first feel numb and heavy, and then become stiff; drowsiness and an irresistible desire to sleep take hold of the sufferer. If left alone, unconsciousness and death rapidly follow.

Frost-bite is an actual freezing of a part by intense cold. Generally the ears, nose, or extremities are affected. The parts first look red or blue, and then become pale or mottled. Their vitality may be so completely destroyed at the time that later gangrene sets in.

Treatment.—In treating a frost-bitten or frozen person avoid above all things the use of heat to the body, and be careful to bring about reaction slowly. Bringing a frozen person suddenly into a warm room may result fatally. The proper thing to do is to place the sufferer in a cold atmosphere, and gently rub the body with ice, snow, or cold water, supplying friction with the hands or a towel until the circulation is reëstablished. Then as the patient reacts he may be gradually covered with blankets and removed to a warmer room. The later treatment consists in the use of stimulants and proper nourishment, which may have to be given by the rectum. Should gangrene of a frostbitten part occur, amputation will in all probability be necessary.

Chilblain is a condition, usually seen in the face, ears, nose, or extremities, the result of congestion following exposure to cold, or it may be produced by the too rapid application of warmth to a frozen part. The warmth produces a dilatation of the blood-vessels and consequently the blood, which has been driven from the part by the intense cold, returns in an excessive amount. Swelling and local congestion occur, followed by an intense itching and burning sensation in the part with the formation of blebs. These symptoms usually disappear in a day or two, but, if the part is again exposed to cold followed by a sudden change in the temperature, the condition may become permanent and be felt after any exposure to even slight cold. A person once frozen or frost-bitten is very liable to suffer from chilblains.

Treatment.—As a preventive against chilblains always be careful to restore the circulation in a frozen part gradually. The actual treatment of the condition should be left to a physician.

CHAPTER XV.

FRACTURES.

This is one of the most important classes of injury we have to deal with, not only from the fact that it renders the victim a cripple for the time being, but also because so much of the future usefulness of the limb depends upon a recognition of the trouble and its proper immediate treatment. Frequently carelessness or ignorance in handling a fracture at the start renders the sufferer an invalid for life.

A fracture may be defined as a break in a bone. It may occur in any of the bones if sufficient force is applied to them, but is more liable to occur where the bones are brittle, as in certain diseased conditions, or old age. In children the bones are soft and tend to bend rather than break.

Fractures caused by blows delivered directly at the seat of injury are said to be due to *direct violence*. Fractures produced by *indirect violence* do not occur at the point at which the force is applied, but such force is transmitted and expended upon some distant part. For example, a person may fall and strike on his feet and yet receive a fracture at the hip. Fractures *from muscular action* are rare. They are produced by the violent contraction of a muscle acting suddenly on a bone. As an example, the muscular action brought into play in throwing a ball may produce a fracture of the humerus.

Varieties of Fractures.—Fractures are classified as incomplete, complete, simple, compound, multiple, comminuted, complicated, and impacted.

An Incomplete Fracture is one where the bone is broken or bent, but not broken entirely through. It is also called "greenstick" fracture, and often occurs in children.

A Complete Fracture is one where the bone is severed through its entire thickness.

A Simple Fracture is one in which the bone is broken, but no communication exists between the fracture and the exterior.

A Compound Fracture is one in which an open wound leads from the surface of the body or mucous surface to the seat of fracture.

A Multiple Fracture is one where the bone is broken into more than two fragments. The lines of fracture, however, do not communicate with each other.

Fig. 159.—Green-stick fracture (Da Costa).

Fig. 160.—Complete fracture of both bones of the leg (Hoffa).

A Complicated Fracture is a break in the bone accompanied by an injury to some of the surrounding parts,—as, for example, a joint, muscle, nerve, or blood-vessel.

A Comminuted Fracture is one where the bone is broken into several pieces, the lines of fracture communicating with each other.

An Impacted Fracture is one in which one fragment of bone is driven into the other, the two remaining tightly wedged.

The Repair of Fractures.—When a bone breaks there is always an injury to the periosteum and surrounding tissues and some hemorrhage about the ends of the fragments, and the space between the two fragments rapidly becomes filled with a blood-clot. A mild inflammation in the immediate neighborhood of the fracture soon follows, and as a result there is a mass of new-

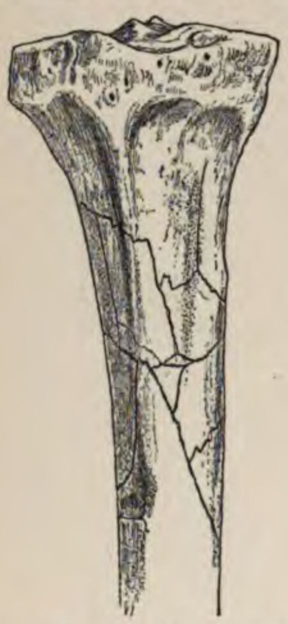

Fig. 161.—Comminuted fracture of the tibia (Pilcher and Warbasse).

Fig. 162.—Impacted fracture of the tuberosities of the humerus (Bardenheuer).

formed tissue called *callus*. It lies between the bones, surrounds the ends of the fragments, and, as it were, glues them together. At first this callus consists only of fibrous tissue, but later there is a growth of bone cells, and a deposit of lime salts occurs which changes the callus into dense bone. A callus may be felt as a distinct knot or projection at the seat of fracture for some time after the bone has united, but later disappears through absorption. Fractures which unite, but in which the callus remains as fibrous tissue, having failed to ossify or harden, are spoken of as having "fibrous union."

The Signs and Symptoms of Fracture are pain, swelling, discoloration, deformity, abnormal motion, loss of power, and crepitus.

Pain.—Some slight pain is always present in a fracture, and in some cases the pain may be quite severe and sharp, lasting for some time after the injury and quickly recurring upon any movement of the limb.

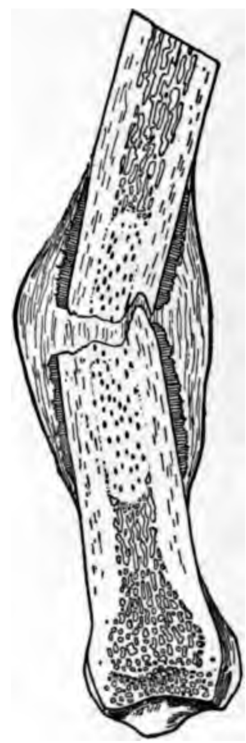

Fig. 163.—Callus of fracture (dog) four weeks; commencing ossification of external callus (Warren).

Swelling and Discoloration appear soon after the injury, their presence being due to the wounding and contusion of the soft parts.

Deformity of the limb is partly the result of swelling and partly due to the displacement of the broken fragments. The bones become displaced from the weight of the limb and from muscular contractions acting upon them. As a result the shape of the limb is distorted, or abnormal shortening occurs. Hence, in examining a limb for fracture it is advisable to compare the limbs of both sides, as sometimes one can discover at a glance a fracture from the unusual outline of the limb.

Abnormal Mobility is a positive sign of fracture and consists in motion obtained at points in a limb where normally if the bones were not broken no movement could possibly occur. In impacted fractures this sign will be absent.

Loss of Power consists in an inability of the patient to move the limb.

Crepitus is the harsh grating which may be felt and, at times, heard when the two ends of a broken bone are moved upon one another. It is a sign sometimes elicited during examination of a broken limb, ***but should never be sought for.***

Examination of a Limb for Fracture.—When examining a limb supposed to be fractured, much may be learned by closely questioning the patient as to how he received his injury, whether he was able to use the limb after being hurt, etc. Usually it will not be necessary to remove the clothing to discover the injury, as the distorted shape of the limb and the pain caused by touching or moving the part are sufficient to make us reasonably sure of the trouble; or the sufferer himself may make a diagnosis, saying he felt something give away or heard a bone snap.

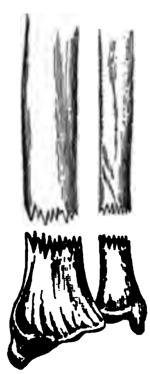
Fig. 164. — Appearance of the ends of fragments (Da Costa).

Begin the examination of the limb by first passing the fingers down the bone supposed to be injured, using moderate pressure, and at some point there will be discovered an area of increased tenderness. Then gently move the limb and ascertain if there is any false point of motion, but do not try to produce crepitus. If still in doubt, compare the limbs of both sides as to shape and length and, if necessary, measure them, taking the measurements between some prominent bony points. In making this examination always remember to disturb the part as little as possible and to use the greatest care and gentleness. On no account lift a broken limb without supporting it by a hand placed beneath each fragment.

When there is any doubt at all as to whether a limb is broken, it is safer to treat it as such until examined by a surgeon.

The Immediate Treatment of a Simple Fracture.—If we consider that the ends of a broken bone are usually sharp and irregular, it can readily be seen how easy it is by carelessness in moving a patient or by rough handling of a broken limb to cause these sharp fragments to protrude through the tissues and skin, thus converting what was at first a comparatively simple injury into one which is exceedingly grave and may result in the loss of his limb. Even the slightest movements of a broken limb, while they may not go so far as to convert a simple into a compound fracture, may cause an injury to the surrounding tissues, nerves, or blood-vessels which is irreparable. For this reason never allow a broken limb to hang dangling or to become twisted.

The immediate treatment, then, should consist in so immobilizing the parts by the application of splints that any further injury is prevented. This must be done upon the spot. *Never*

Fig. 165.—Treatment of a fracture of the leg without splints.

allow a person suffering from a broken limb to be moved until the part is properly splinted.

Splints.—In an emergency any material which has sufficient firmness to give support to a limb will answer for splints. Umbrellas, canes, swords, guns, cigar boxes, firewood, wire, leather, laths, bed-slats, barrel staves, several thicknesses of a newspaper, pillows, or a folded coat may be used. In the country twigs, bark, branches of trees, bundles of straw or hay, cornstalks, or a short fence-rail may be utilized. For permanent splints some soft pine or other wood about one-quarter to one-half inch thick and three to four inches wide should be procured, the length depending on that of the limb we wish to confine. As a general rule splints should be long enough to confine the joint above and below the seat of fracture and should be somewhat broader than the limb itself. More elaborate splints are made from tin, plaster-of-Paris, felt, or binders' board. In fracture of the leg or thigh, if no splints can be obtained, the broken limb may be immobilized by tying it to the sound limb, the latter then acting as a splint (Fig. 165).

The Application of Splints.—Splints may be applied temporarily over the clothing and should always be well padded,

Fig. 166.—Temporary splints applied to the arm.

as a hard board against an injured limb soon becomes very painful. Oakum, cotton, grass, moss, portions of clothing, or any soft material will answer for the padding. If possible, two splints should be applied to a limb; while in fractures of the leg three are generally used, one on each side and one behind. In applying splints have an assistant hold them in position, and then firmly fasten them to the limb by several turns of a roller bandage, adhesive strips, handkerchiefs, pieces of rope, or portions of clothing. Before applying the splints, any deformity of the limb should be reduced by gentle traction, when the limb will usually assume its natural shape.

Having provided a temporary support for the broken limb, the patient may be removed to a hospital or his home, where he can receive proper surgical attention. *On no account allow a person suffering from a fracture of the lower extremity to walk,* even if splints are applied. Always provide a stretcher or some other means of conveyance.

The Treatment of a Compound Fracture.—To properly treat a compound fracture the clothing about the injured part should be removed. Always remove the clothing from the uninjured limb first and then from the broken limb very carefully, cutting the clothing away if necessary. If trouble is taken to cut along the seams but little damage is done to the garments, and they may be sewed up later, but do not hesitate to destroy a garment if in so doing the sufferer can be saved unnecessary pain.

Sufficient has already been said about the dangers of a compound fracture to act as a warning. Never touch such a fracture unless the hands are absolutely clean. If medical aid is at hand, the immediate treatment should consist in controlling any bleeding, placing an antiseptic or clean pad over the wound without removing the blood-clots, and immobilizing the limb by splints.

If surgical aid is not at hand or cannot be obtained, such fractures will require much more thorough treatment than outlined above. Remember that the whole future usefulness of the limb may depend upon the first treatment, so the greatest cleanliness should be observed in order to prevent any infection of the part. The skin surrounding the wound must be shaved, thoroughly cleaned, and disinfected, and the wound itself should be washed out with some antiseptic solution, care being taken to remove any foreign bodies. If the bones project from the wound, they should be cleaned with an antiseptic solution and replaced. Slight traction upon the limb will generally suffice to accomplish this; but, should any difficulty be experienced, it will be necessary to enlarge the opening in the skin. Then place a small drain in the wound, and finally apply an antiseptic dressing and properly support the part with splints. The drain may be removed after an interval of several days.

FRACTURES OF SPECIAL BONES.

Fracture of the Skull may occur in the vault or base. Fractures of the vault are the result of blows or falls upon the head. Fractures of the base are the result of indirect violence resulting from falls upon the feet or blows upon the jaw.

Fig. 167.—Comminuted fracture of the skull (Hoffa).

Symptoms of concussion and compression of the brain usually accompany a fracture of the skull (see Concussion and Compression, pp. 270 and 271), as there is always more or less severe injury to the brain substance, and frequently compression from blood or bone results. The person, as a rule, is unconscious. In fracture of the base there may be bleeding from the ears or nose and an escape of cerebrospinal fluid from the ears. Later, a subcutaneous hemorrhage (ecchymosis) develops about the eyes.

Treatment.—Send for medical aid. In the meantime dress any wound upon the head with an antiseptic pad or clean compress. Have the patient removed to a cool room and kept as quiet as possible, with ice applied to the head. If shock is present, heat should be applied to the heart and extremities, *but avoid stimulants.*

Fig. 168.—Fracture of the nose dressed with two small bandages and adhesive strips.

Fracture of the Nose is the result of direct violence applied to that region. There may be no external sign of the injury; again, there may be considerable swelling and deformity, the bones being flattened or pushed to one side and capable of being easily moved by manipulation. The injury is usually accompanied by a profuse hemorrhage from the nose.

Fig. 169.—Fracture of the lower jaw, showing loss of alinement of teeth (Scudder).

Treatment.—Return the bones to their normal position, if possible, by gentle manipulations. To retain them in position we may employ two very small rolls of narrow bandage, held upon each side of the nose by strips of adhesive plaster. Little else in the way of treatment is required except to keep the nose clean; if there is much bleeding, the nostrils may have to be packed. (See Bleeding from the Nose, p. 186.)

Fracture of the Lower Jaw is a quite common accident, and may be caused by falls, blows, kicks upon the chin or sides of the face, or even by rough extraction of a tooth. This injury is usually compound, the mucous membrane of the mouth being torn so that there is a wound leading from the cavity of the mouth to the seat of fracture. Infection is very liable to follow through the entrance of food and bacteria. Fractures may occur at any point in the bone, but the usual seat is through the body of the jaw.

Fig. 170.—Treatment of fracture of the jaw.

Deformity is manifested by an unevenness in the line of the teeth. There is an inability on the part of the sufferer to talk clearly, and dribbling of saliva and blood occurs from the mouth. Pain is present to a marked degree.

Treatment. — The greatest difficulty may be met with in keeping the broken fragments in position. Get them in as good position as possible, however, and hold them there by means of a four-tailed bandage, Barton's bandage, or Gibson's bandage. Above all, see that the mouth is kept clean, using for this purpose a saturated solution of boric acid or some good mouth wash. The patient should later consult a surgeon or be advised to have an interdental splint made by a dentist so that the broken fragments may be held in proper position.

Fractures of the Spine are comparatively rare and are usually accompanied by the dislocation of a vertebra. The injury may be the result of either direct or indirect violence. As a rule the fracture of a vertebra is accompanied by more or less injury to the spinal cord, resulting in paralysis of the extremities and loss of sensation. The local symptoms of pain and deformity are also present. The deformity can usually be discovered by passing the fingers lightly down the spine.

Treatment.—Very little can be done in the absence of medical assistance. The patient should be kept quiet, lying flat on the back. If it is necessary to move him, it should be done with extreme care to prevent any additional injury to the spinal cord. Shock should be treated by the application of heat to the extremities.

Fig. 171.—Partial fracture of twelfth dorsal and fracture of first lumbar vertebræ (Warren Museum, specimen 941).

Fracture of the Ribs may be produced by blows, crushing forces, and by heavy bodies passing over the chest. Muscular action is also said to be a cause. The usual location for the fracture is between the third and eighth ribs. These fractures are frequently accompanied by wounding of the pleura or lung, and pleurisy or pneumonia is very apt to be a sequel.

The symptoms are pain, a "stitch" in the side, and great difficulty in breathing. With extensive injury to the lung substance there may be spitting up of blood and an escape of air beneath the tissues of the chest, a condition called emphysema. It is easily recognized by the sharp crackling sensation imparted to the fingers. On examination, by passing the fingers along each rib in succession, one will be able to elicit a false point of motion or crepitus in one or more of them. By placing the ear against the injured side and asking the patient to take a deep breath, crepitus may be distinctly heard.

Treatment.—The main thing is to prevent any possible injury to the lung and to afford some relief from the pain. This can only be accomplished by immobilizing the injured side.

Fig. 172.—Fracture of the ribs. Starting the application of the adhesive-plaster swathe to encircle the trunk (Scudder).

As a temporary dressing a broad binder of muslin, a many-tailed bandage, a triangular bandage, a cravat bandage, or an ordinary roller bandage, applied firmly around the chest, will afford much relief.

Strapping the chest, however, is the best treatment both in emergencies and as a later treatment. Procure a strip of plaster wide enough to cover the injured side, or several strips, each about two to two and a half inches wide and long enough to extend from the spine behind to just beyond the median line in front, and apply as follows: With the patient standing up with arms above his head, tell him to "let out all his breath," and quickly apply the plaster or strips of plaster to the injured side of the chest, beginning well below the fracture and gradually working up, if strips are used. Apply each strip with even firmness, allowing it to overlap one-third of the one below. The plaster is applied at the end of a forced expiration because

Fig. 173.—Fracture of the ribs. Finishing the application of the adhesive-plaster swathe to the trunk (Scudder).

at this time the lungs, being nearly empty and the chest wall relaxed, the broken fragments are more nearly in apposition.

When there is injury to the lungs accompanied by spitting up of blood, keep the patient quiet in bed and give cracked ice by mouth.

Fracture of the Clavicle, or Collar Bone.—The collar-bone is said to be injured the most frequently of all bones. It is a common injury in children. The fracture may be caused by direct violence or by indirect violence from falls upon the hand,

and may be located in any portion of the bone, but the usual seat is at the junction of the outer and middle third.

The weight of the arm drags down the outer fragment and produces a well-marked deformity; the shoulder drops downward and forward, and the patient will usually support the arm with the uninjured hand. There is considerable pain and an inability to use the arm. Examination of the bone will reveal the deformity and irregularity of its outline, while upon manipulation a false point of motion can readily be obtained.

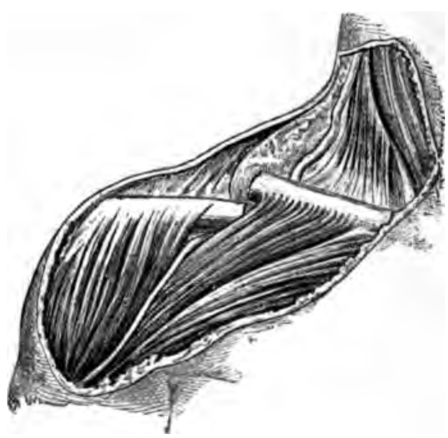

Fig. 174.—Fracture of the middle portion of the clavicle (Anger).

Treatment.—As an emergency dressing, a large arm-sling with a pad in the armpit and the arm bound to the side will answer; or, if one is expert in bandaging, a Velpeau or Desault bandage may be applied.

Another excellent temporary dressing consists in a four-tailed bandage. Each end of a piece of muslin six to ten inches wide is split into two tails to within five or six inches of each other. The central part is placed under the elbow of the injured side, while the hand of the same side rests upon the opposite shoulder, a pad or towel being placed in the armpit. The two lower ends of the bandage pass up, one from behind and the other in front, to the opposite shoulder, where they are tied;

Fig. 175.—Treatment of a fractured clavicle with a large arm-sling.

Fig. 176.—Fracture of the clavicle dressed with a four-tailed bandage.

the two upper tails are secured around the chest, thus fastening the arm to the side.

Much the same dressing may be applied by using two cravat bandages. One supports the elbow and is fastened upon the opposite shoulder; the other secures the arm to the side of the chest.

The later treatment consists in the application of any dressing which will keep the shoulder up, back, and outward, thus holding the broken fragments in their normal position. Many forms of dressing have been devised for this purpose, the Velpeau, Desault, or Sayre dressing being most frequently used.

Fig. 177.—Fracture of upper and lower ends of the shaft of the humerus, showing displacement (Hoffa).

Fracture of the collar-bone is sometimes treated without any dressing at all, simply having the patient lie flat on his back upon a hard bed with the arms placed across the chest and a narrow cushion between the shoulder blades. The patient is allowed to be up in from two to three weeks, the arm being supported in a sling.

Fracture of the Scapula is not a very common injury. The fracture is usually caused by direct violence, and may occur in the body, the neck, the acromion process, or the coracoid process of the bone. The usual signs and symptoms of a fracture—pain, swelling, disability, and crepitus—are present, but there may be some difficulty in locating its exact seat.

Treatment.—Fractures through the body of the bone are best treated by a compress over the seat of injury and immobilization of the arm.

Other fractures of this bone are to be put up with a pad in the armpit and the arm supported in a large arm-sling, or else apply a Velpeau or Desault bandage.

Fractures of the Humerus, or arm-bone, may be caused by blows upon the arm, falls upon the hand or shoulder, and by muscular action, and may occur in any part of the bone.

Pain, deformity, false point of motion, and disability of the arm may all be present. A fracture in the neck of the bone may be hard to recognize. In such a case there is usually pain and swelling about the shoulder and inability to use the arm; if the arm is rotated with the fingers placed in the armpit, it will be found that the head of the bone does not move and crepitus may be felt near the shoulder-joint. Fracture high up in the bone may produce injury to the vessels in the armpit, so it is well to examine the pulse at the wrist in dealing with such an injury.


Fig. 178.—Temporary dressing for fracture of the humerus in its upper third.

Treatment.—A fracture of the neck or upper third of the bone may be put up temporarily by placing a pad or folded towel in the armpit and securing the arm to the side with a bandage. Then place a sling about the wrist. With this dressing the weight of the arm and forearm acts as an extension.

Fracture in the middle of the shaft of the bone may be treated by the use of two broad splints; or, better, four narrow ones, placed about the seat of injury and secured by a bandage or strips of adhesive plaster, the wrist being supported by a sling. Care must be taken, however, that the inner splint does not extend too high in the armpit, as it might thus compress the blood-vessels or at least be exceedingly uncomfortable for the patient.

A fracture near the elbow-joint mav be dressed temporarily by simply applying a large arm-sling and securing the arm to the body. In injuries near the elbow-joint, when put up permanently, the forearm should be kept at a right angle to the arm. For this purpose a right-angle splint will be required; it may be quickly made by nailing or tying the ends of two splints together. The forearm is then bent at a right angle, and the splint, previously well padded, is placed on the inner side of the arm and forearm, being secured at the wrist and below the shoulder by a few turns of a bandage or by adhesive strips. Finally, support the forearm in a sling.

Fig. 179.—Temporary dressing for a fracture of the shaft of the humerus.

Fig. 180.—Fracture of both bones of the forearm, with marked angular deformity (after Bruns).

Fractures of the Forearm may be produced by blows or falls upon the forearm or hand, either one or both bones being broken at the same time.

When both bones are broken, the fracture is rarely on the same plane in each bone. The injury is easily recognized, as there is generally a well-marked deformity.

When only one bone is injured, the other acts as a splint, and but little deformity will be apparent, but there is inability

Fig. 181.—Fracture of both bones of the forearm.

to use the forearm, and, on examination, a false point of motion can be discovered in the injured bone.

There is a common fracture of the lower end of the radius, the result of falls upon the hand, known as Colles' fracture, or the "silver fork" fracture, deriving the latter name from the fact that the deformity gives to the limb the appearance of a fork.

Fig. 182.—Colles' fracture, radial side (Scudder).

Treatment.—In treating fractures of the forearm, the limb should be put up with the elbow bent at a right angle, the forearm across the chest, with the palm of the hand turned in and the thumb pointing upward. First reduce the deformity by gentle traction upon the hand, and then apply two well padded splints to the seat of fracture, having them long enough to extend from the elbow to below the wrist; bandage the splints

Treatment.—Put the limb up straight, with a well-padded splint behind the leg. The two fragments of bone can be brought together by strips of adhesive plaster or by a figure-of-eight bandage, the turns passing above the upper fragment and below the lower one (Fig. 190). Ice should be applied to the joint with the object of limiting and decreasing the swelling.

Fracture of the Leg may occur from direct or indirect violence, and, as in the forearm, one or both bones may be broken.

A fracture of the lower end of the fibula, spoken of as Pott's fracture, is a common injury produced by the foot turning suddenly or twisting under. It is generally accompanied by tearing of the internal lateral ligaments of the ankle-joint or by a fracture of the internal malleolus, and is characterized by great deformity and turning out of the foot.

Fig. 191.—Fracture of both bones of leg at middle third (made from X-ray picture) (Eisendrath).

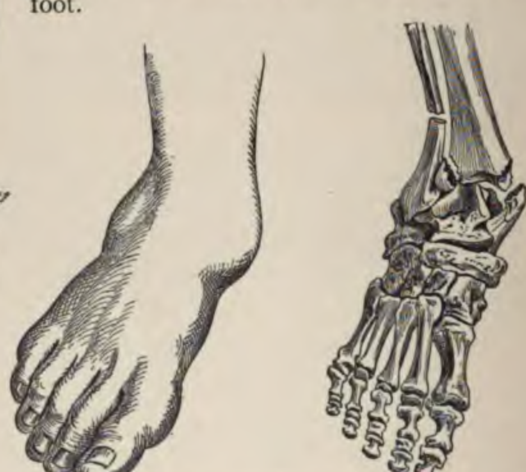

Fig. 192.—Pott's fracture, showing deformity (Hoffa).

Treatment.—In a Pott's fracture reduce the deformity by *turning the foot well in* and apply a well-padded side splint on the inner side of the leg, extending from the knee to below the foot.

If both bones are broken, it is well to apply three splints, two side splints and a posterior one, to give added support and

Fig. 193.—Treatment of Pott's fracture.

prevent a backward sagging at the seat of the break. A pillow will take the place of a posterior splint in an emergency, as shown in Fig. 194.

Fig. 194.—Fracture of the leg. Temporary dressing with pillow, side splints, and straps (Scudder).

Fracture of the Metatarsal Bones, or foot, is usually the patient lie quietly on his back, apply a tight binder or bandage to the hips, and also fasten the knees together. The patient should be moved only with extreme care, using for this purpose a stretcher which is firm and will not sag; it is well to fasten the patient securely to the stretcher in order to prevent swaying or any movement of the body. Later, he should be placed upon a firm bed, with the thighs flexed upon a pillow. If shock be present, treat by the application of heat to the heart and extremities.

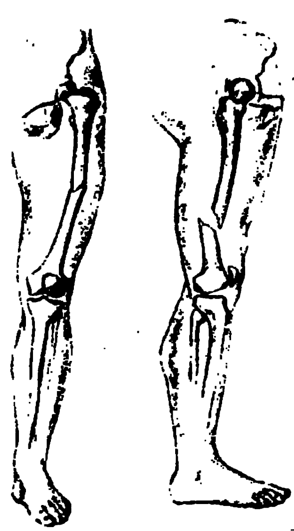

Fig. 186.—Fracture of the femur, showing the more usual deformities (Scudder).

Fractures of the Femur, or thigh, may be due to direct or indirect violence, and may occur in the neck, shaft, or lower extremity of the bone. Fractures of the shaft generally occur in young children or young adults, while those of the neck are more common in persons past the age of fifty. This is due to the fact that in old persons the structure of the bone becomes weakened and degenerated, so that very slight injuries, as tripping and falls of a few feet, are liable to produce a fracture.

Fractures of the femur are serious injuries because there is always more or less shortening of the limb, due to the muscles contracting and pulling upon the broken fragments, which is hard to overcome and frequently results in deformity and permanent disability. The shortening of a limb after a fracture of the shaft varies from one to three inches, but in fracture of the neck of the bone it is less, usually amounting to from one-fourth to one-half inch.

At times there may be some difficulty in recognizing the injury, on account of the numerous muscles which cover the bone; but keeping in mind the following signs and symptoms will be of assistance: The patient usually lies with the toes of the injured leg pointing outward; any attempt to move the limb results in a spasm of the muscles and causes the patient excruciating pain; there is loss of power in the limb, the patient being unable to lift it. On examination, some swelling is usually present about the seat of injury, and, if the fracture be in the shaft of the bone, a false point of motion will be discovered.

The shortening of the injured limb may be estimated by having the patient lie flat on his back and measuring each limb from the anterior superior spine (the bony prominence felt above the groin) to the tip of the internal malleolus (the bony prominence above and to the inner side of the ankle-joint).

Fig. 187.—Fracture of hip or thigh. Emergency apparatus (Scudder).

This can be roughly done by using a string, if a steel tape measure is not available, and any difference in the length of the two bones will be readily appreciated.

Treatment.—A long splint reaching from the armpit to below the foot should be applied, a bed-slat makes an excellent splint, but, if nothing better is at hand, a splint may be improvised from a gun-barrel or part of a fence-paling. Pad the splint and apply it to the outside of the injured leg, fastening it to the waist and to the limb at different points. Care must be taken to bind the foot to the splint to prevent the foot from turning. Such a splint may be applied to the limb without lifting the patient from the ground by simply slipping strips of bandage or adhesive plaster under the limb at intervals and securing each one separately.

The above appliance answers for emergencies and as a temporary dressing, but, where no surgical aid can be obtained, a more permanent apparatus will be needed, one that will exert traction upon the limb, and so overcome the shortening. Such an apparatus may be made and applied as follows: Obtain a piece of adhesive plaster or, better, moleskin plaster, about three inches wide and long enough to reach up on each side of the thigh to the seat of fracture and still extend below the foot for a distance of two inches in the form of a loop. A thin block of wood three inches wide and about five inches long with a hole in its center is next placed in this loop and secured by strips of adhesive plaster. Have the person placed on a firm, flat bed, and, having heated the

Fig. 188.—Fracture of the thigh. Extension apparatus (Scudder).

plaster, apply it to each side of the thigh and secure by a few turns of a bandage. As soon as the plaster becomes set and firm, fasten a rope through the hole in the foot piece and carry it over a pulley previously fastened to the foot of the bed. Sufficient weight to overcome the shortening in the limb must be applied to the rope. This will vary from eight to twenty pounds. The foot of the bed should be elevated four or five inches, so that the weight of the body will act as a counter-extension and will also prevent the patient being pulled down by the weight attached to his leg. The limb will have a tendency to turn outward, and this should be corrected by placing a long side splint upon the limb or by placing sand-bags upon each side of it. These are easily made by taking two canvas bags, three to four inches in diameter and long enough to extend from the hip to below the foot, and filling them with dry sand. In place of the plaster, a shoe may be worn upon the foot of the injured leg to the bottom of which is fastened the rope and weight.

Fig. 189.—Transverse fracture of the patella (Hoffa).

Fracture of the Patella, or knee-cap, is caused by falls or blows upon the knee and by muscular action. A person will sometimes start to trip or fall backward, and, in attempting to recover the balance, the muscular exertion is sufficient to snap this bone.

After such an injury the patient loses control over his leg and is unable to extend it, but he may be able to stand up after once being assisted to his feet. The injury is easy to discover, as there is usually a marked separation of the two fragments, with a consequent tearing of the ligaments about

Fig. 190.—Treatment of a fracture of the patella.

the joint; the joint becomes much enlarged from the effusion of blood and serum and from the swelling of the surrounding tissues.

Treatment.—Put the limb up straight, with a well-padded splint behind the leg. The two fragments of bone can be brought together by strips of adhesive plaster or by a figure-of-eight bandage, the turns passing above the upper fragment and below the lower one (Fig. 190). Ice should be applied to the joint with the object of limiting and decreasing the swelling.

Fracture of the Leg may occur from direct or indirect violence, and, as in the forearm, one or both bones may be broken.

A fracture of the lower end of the fibula, spoken of as Pott's fracture, is a common injury produced by the foot turning suddenly or twisting under. It is generally accompanied by tearing of the internal lateral ligaments of the ankle-joint or by a fracture of the internal malleolus, and is characterized by great deformity and turning out of the foot.

Fig. 191.—Fracture of both bones of leg at middle third (made from X-ray picture) (Eisendrath).

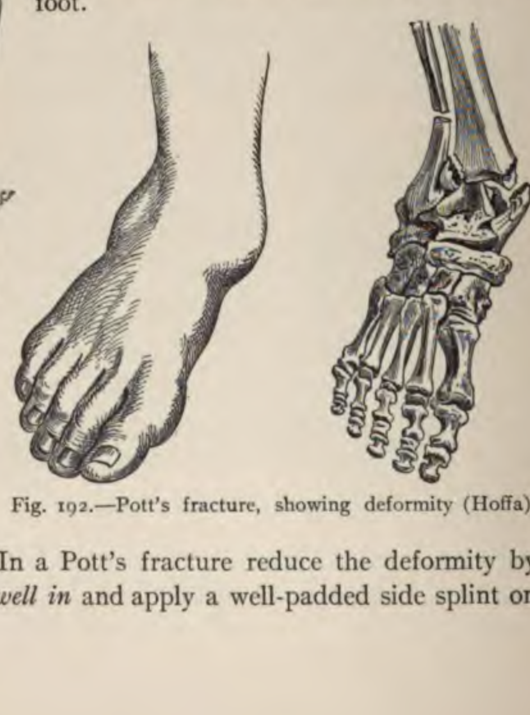

Fig. 192.—Pott's fracture, showing deformity (Hoffa).

Treatment.—In a Pott's fracture reduce the deformity by *turning the foot well in* and apply a well-padded side splint on the inner side of the leg, extending from the knee to below the foot.

If both bones are broken, it is well to apply three splints, two side splints and a posterior one, to give added support and

Fig. 193.—Treatment of Pott's fracture.

prevent a backward sagging at the seat of the break. A pillow will take the place of a posterior splint in an emergency, as shown in Fig. 194.

Fig. 194.—Fracture of the leg. Temporary dressing with pillow, side splints, and straps (Scudder).

Fracture of the Metatarsal Bones, or foot, is usually the result of a crushing force, as a heavy weight dropped upon the foot or a wagon-wheel passing over it.

Treatment.—Apply a light splint to the sole of the foot and keep the foot immobilized by two side splints extending up the leg from below the foot.

CHAPTER XVI.

DISLOCATIONS, SPRAINS, AND STRAINS.

DISLOCATIONS.

A dislocation is a complete separation or displacement of the articular surfaces of a joint.

Dislocations are usually the result of direct violence, but may be produced by indirect violence or muscular action. They may occur at any age, but are more frequently seen in adults and are rare in children and the aged. Joints which permit free motion in all directions, as ball-and-socket joints, the shoulder being an example of such, are most liable to this injury.

Dislocations are always very painful injuries because they are accompanied by wrenching and tearing of the ligaments about the joint. They are frequently complicated by rupture of muscles and injury to the neighboring vessels and nerves.

Like fractures they are classified as *simple*, *compound*, and *complicated*.

Symptoms.—Pain of a sickening character is present, swelling and ecchymosis about the injured part rapidly appear, and in addition there are several signs peculiar to this form of injury. There is always rigidity of the part, due in a measure to the abnormal relation of the bones and also to muscular spasm. The direction of the limb is changed, and likewise its length. On account of the alteration in the relation of the bones the shape of the joint is altered,—for example, the shoulder-joint usually appears flattened, while dislocations about the elbow result in a projection of the bones which produces a well-marked deformity. Upon examination one will be able to feel the head of the dislocated bone in an abnormal position.

A dislocation may be distinguished from a fracture near a joint by the fact that in the former there is rigidity of the limb, while in a fracture there is undue motion; also, in a dislocation bony crepitus is absent.

General Treatment of Dislocations.—The treatment consists in restoring the bones to their normal position, spoken of as reducing the dislocation, and then so confining the parts that a recurrence of the trouble will be impossible.

To properly reduce a dislocation requires considerable knowledge and some skill. *It must be remembered that rough manipulations or pulling upon the limb will often result in grave injury.* While at times we will be surprised by the ease with which some dislocations are reduced, the bones often slipping back into place after some slight movement or gentle manipulation, it more frequently happens that a general anesthetic will be necessary before reduction can be effected, so that medical aid should always be summoned. In the meantime, simply immobilize the injured part by a sling, bandage, or splints.

For the benefit of those who may be in a position where medical aid cannot be obtained, the simplest methods for the reduction of some of the more common dislocations are described below, *it being understood that such reductions, excepting possibly those of the lower jaw and fingers, should never be attempted by one unskilled, when medical aid is within reach or can be obtained within twelve to twenty-four hours.*

SPECIAL DISLOCATIONS.

Dislocation of the Lower Jaw is usually due to a blow upon the mouth when the jaws are open, or it may be caused by yawning or laughing. After such an accident the jaws are held rigid and widely opened, the lower jaw being brought forward so that the patient is unable to close the mouth.

Treatment.—Have the patient sit in an upright position in a chair and have the head held from behind by an assistant. Then place the thumbs upon the last molar teeth of each side, and, grasping the chin firmly between the fingers and thumbs, press downward and backward on the jaw, and pull upward upon the chin. This will usually result in the jaw returning to its normal position with a snap. Care must be taken that the thumbs are not bitten during this manipulation, and it is well to protect them with a bandage or towel before attempting the reduction. After reduction is completed, retain the jaw in position by a Barton or a four-tailed bandage.

Fig. 195.—Dislocation of the lower jaw.

Dislocation of the Thumb or Fingers usually occurs backward upon the dorsum of the hand.

Treatment.— Reduction of a backward dislocation of the thumb may be accomplished by bending the dislocated bone backward and at the same time making traction. With the other hand attempt to push the head of the bone into its proper position. Follow this by flexing the thumb (Fig. 198).

Dislocations of the fingers may be reduced by simple traction, accompanied by manipulations which aim to push the head of the bone back into its proper position.

Fig. 196.—Method of reducing a dislocation of the jaw (Makins).

Dislocation of the Shoulder.—The shoulder-joint suffers from dislocation more frequently than any other joint in the body. With this dislocation the arm is held rigid, and the elbow stands off quite a distance from the body. The shoulder

Fig. 197.—Backward dislocation of first phalanx of thumb (Helferich).

Fig. 198.—Reduction of a dislocation of the thumb.

appears flat, and there is a marked depression beneath the point of the shoulder. In addition there is pain and swelling at the seat of injury.

Treatment.—Reduction may be accomplished by certain manipulations known as Kocher's method, or by strong traction upon the arm.

Kocher's method.—Have the patient lie flat on a hard table or the floor, and place the arm of the injured side close to the body, flexing the forearm (Fig. 200). Then grasp the forearm and, using it as a lever, *slowly* rotate the arm outward until the forearm extends almost at a right angle to the body (Fig. 201). Next raise the arm slightly from the body and bring the elbow forward, still keeping the forearm at a right angle to the body. The fourth step consists in carrying the arm across the chest while traction is made upon it, at the same time making inward rotation with the arm, using the forearm as a lever (Fig. 202). The main thing in making these manipulations is to keep up the external rotation long enough to thoroughly tire out the muscles at the shoulder.

Fig. 199.—Subcoracoid dislocation of the humerus (Hoffa).

Reduction by Traction or Extension is a less complicated procedure, and consists in simply pulling upon the arm. Place the patient upon his back on the floor or upon a table. Then the operator, after taking off his shoe, should insert the heel under the armpit and make traction upon the arm downward and slightly toward the patient's body (Fig. 203).

Having reduced the dislocation, the subsequent treatment consists in immobilizing the arm. This may be done by using a sling and binding the arm to the body, or by applying a Velpeau or Desault bandage without the pad in the armpit.

Dislocation of the Elbow.—A great variety of dislocations occur in this joint. There may be a dislocation of one bone or of both the radius and ulna, and it may occur forward, backward, or sideways. These dislocations are usually caused by blows upon the elbow or by falls upon the hand.

Fig. 200.—Reducing dislocation of the shoulder; first step (Makins).

As a rule, the forearm is flexed and held rigid. When the bones are dislocated backward, there is a projection of the olecranon behind the elbow and shortening of the forearm (Fig. 204). In a forward dislocation the forearm is lengthened.

Fig. 201.—Reducing dislocation of the shoulder; second and third steps (Makins).

Treatment.—It is hard to lay down any general rule for treatment, as each variety of dislocation should be reduced by different manipulations. Most of these dislocations may, however, be reduced by first flexing the forearm on the arm and

Fig. 202.—Reducing dislocation of the shoulder; fourth step (Makins).

then making traction upon the flexed forearm near the joint,

Fig. 203.—Reduction of a dislocation of the shoulder by traction.

and, at the same time, using pressure over the dislocated bones.

Follow this by extending the forearm. After reduction immo-

Fig. 204.—Dislocation of radius and ulna backward, showing position of the ends of the dislocated bones, deformity of elbow, and position of forearm (Hoffa).

bilize the arm and forearm, the arm being in a flexed position.

Fig. 205.—Reduction of a dislocation of the elbow (Makins).

Dislocations of the Hip are of several varieties, described according to the direction the head of the femur takes, but for all practical purposes they may be divided into forward and backward dislocations. In both these dislocations the limb is held rigid and pain is marked.

In forward dislocations the thigh is somewhat flexed and held outward away from the median line, the foot being also turned out. The limb may be either lengthened or shortened.

In backward dislocations the foot is turned inward, while the thigh is drawn toward or across the opposite limb. Shortening of the limb is also marked.

Treatment.—They are all difficult to reduce, each variety, like those of the elbow, requiring some different manipulation. Usually an anesthetic to relax the muscles is necessary to insure success.

In *forward dislocations* the leg should be bent upon the thigh and the thigh upon the abdomen, the limb being slightly abducted. Then, rotating the limb inward and at the same time

Fig. 206.—Anterior dislocation of the hip.

Fig. 207.—Posterior dislocation of the hip.

carrying it toward the sound side, bring it down by the side of the uninjured limb (Fig. 208).

In *backward dislocations*, bend the leg upon the thigh and the thigh upon the abdomen as before, but now adduct the limb, bringing it toward the sound side. Then, rotating the limb outward and carrying it out across the abdomen, bring it down by the side of the uninjured limb (Fig. 209).

Dislocations of the Knee are due to the application of great violence. They may occur forward, backward, outward,

Fig. 208.—Reduction of a forward dislocation of the hip.

Fig. 209.—Reduction of a backward dislocation of the hip.

or inward. In the forward and backward variety, the leg is shortened and there is a marked deformity, as shown in Fig.

210. In lateral dislocations, as a rule, there is no shortening of the leg.

Treatment.—Bend the leg upon the thigh and the thigh upon the abdomen, and, while an assistant holds the thigh, make traction upon the leg, and push the bones into their proper position.

SPRAINS OF JOINTS.

A sprain is a twisting or wrenching of a joint with tearing of the ligaments and surrounding soft parts. Sprains are common in the young, or in those whose muscles are flabby and

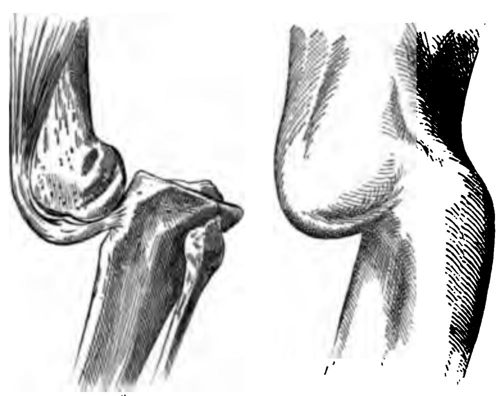

Fig. 210.—Complete posterior dislocation of the head of the tibia (Hoffa).

too weak to furnish the necessary support for the joint. The joints usually affected are those of the ankle, knee, and elbow.

A severe sprain is accompanied by tearing of the ligaments about the joint and stretching of the neighboring tendons and muscles. There may be also some injury to the cartilages, and even portions of bone to which the ligaments are attached may be torn away. Accompanying these injuries there is more or less escape of blood into the joint itself and surrounding tissues.

Sprains are followed by severe pain and marked swelling of the injured part, due to the laceration of tissues and effusion of blood. The sufferer is unable to use the joint, and later ecchymosis and discoloration develop at the seat of injury.

Treatment.—Sprains are most important injuries and permanent disability frequently follows from a failure to give them the proper *immediate* care. Severe sprains are even more serious than fractures. There is nothing more dangerous than to attempt to "walk off" a sprain of the ankle—advice frequently given to the recipient of such an injury. With a slight injury to a joint, exercise may do good, often preventing later stiffness. It is, however, usually impossible to ascertain the severity of the injury at once, and for this reason *every sprain should be treated with great care.* If there is any doubt as to whether the injury is a sprain or a fracture, it should be treated as a fracture until the arrival of medical aid.

In recent sprains the first thing is to prevent any further effusion of blood into the joint. This may be accomplished by the use of pressure and cold applications. Elevate the limb and apply a firm bandage to the joint. An ice-cap may then be applied, or the bandage may be first wrung out in cold water and then applied. Such a bandage should not be put on too tightly, as later, on becoming dry, it is apt to shrink. Lead-water and laudanum is a useful application for the relief of pain. If pain persists under the use of cold, hot applications should be tried; frequently by immersing the part in very hot water for several hours, the pain will be entirely relieved.

As swelling and pain subside, slight movements of the joint and gentle massage should be practised daily. In the intervals, keep the part immobilized by splints.

Treatment of a sprain of the ankle by immediate strapping of the joint and allowing the patient to walk about is frequently practised. For this purpose strips of adhesive plaster one to one and a half inches wide and about eighteen inches long should be obtained. A strip is started well behind at the junction of the middle and lower third of the leg on the injured side, and is carried down under the heel with considerable tension, across the sole, and up the other side of the joint. The middle of another strip is applied to the point of the heel, and the two ends carried forward over the dorsum of the foot, but not far enough to meet. Leg strips and foot strips alternate, interlacing with each other and overlapping the previous strip each time, until the ankle-joint is covered in. Strapping in this manner furnishes pressure and, at the same time, fixes the joint and gives support to the torn ligaments.

Fig. 211.—Strapping for a sprain of the ankle.

STRAINS.

The wrenching or tearing of a muscle or tendon is designated as a strain. Such an injury in a healthy muscle is the result of violent exertion or sudden, unexpected movements, as, for example, recovering the balance. These injuries usually occur in the muscles or tendons of the arm or legs, and may consist of a simple stretching or tearing of some of the muscle fibers or of a rupture through the entire muscle or its tendon.

When such an injury occurs in the leg, the sufferer will be seized with a sudden, sharp, excruciating pain in the injured part, and will often drop suddenly down, saying afterward he thought he had been shot or struck with a stone.

If complete rupture occurs, there will be loss of power of the affected muscle, and, on examination, there will be found a distinct gap with considerable swelling above it, due to retraction of the torn muscle fibers.

Treatment.—For slight strains, strapping with adhesive plaster or the use of bandages gives most comfort.

If rupture occurs, the limb should be immobilized by splints or bandages and placed in such a position that the muscles are relaxed, thus allowing the torn fibers to come together. For example, if the injury is in the leg, the knee should be flexed, being supported in this position by a pillow.

CHAPTER XVII.

ASPHYXIA AND THE REMOVAL OF FOREIGN BODIES.

ASPHYXIA.

Asphyxia, or suffocation, is the interruption or complete suspension of the function of respiration, produced by some interference with the free passage of air to the lungs or by breathing poisonous gases. The result in either case is the same,—there is a very much diminished supply of oxygen in the blood, an increased amount of carbonic acid, and consequent poisoning.

Asphyxia results from a number of causes. Among them may be mentioned drowning, hanging, strangulation, smothering, and obstruction of the air-passages from foreign bodies or from swelling of the mucous membrane which lines them.

The appearance of a person suffering from asphyxia is characteristic. The face becomes swollen and congested; the lips are blue; the eyes are bloodshot; the body is cold; and the hands and feet are swollen and livid. The breathing, which at first is labored, soon becomes spasmodic and finally ceases altogether. The heart, however, may continue beating for some minutes after all breathing has ceased.

Treatment.—In all cases the indications are, first, to remove the cause of the suffocation, then to establish natural breathing, and later to treat the shock by appropriate measures.

Artificial Respiration is a term applied to methods of starting up respirations in persons in whom the breathing has ceased. There are four well-known methods, the Sylvester, the Howard, the Hall, and the Laborde.

The Sylvester Method.—The patient is placed upon his back, the clothing having been previously loosened or removed from the chest, and a pillow or folded towel is placed between the shoulders, thus elevating the chest and throwing back the head so as to maintain an open passage for the air. Make sure that the air-passages are not blocked by foreign bodies or mucus. The throat can readily be cleared by wiping it out with the fingers. Always pull the tongue well forward, and have it held by an assistant. If without assistance, it may be held forward by a rubber band or piece of string placed

Fig. 212.—Sylvester's method of artificial respiration. Inspiration.

around the tongue and secured to the chin; or, after drawing it well out of the mouth, pass a hat-pin through it.

Now kneel at the individual's head, facing toward his feet, and, grasping both elbows, carry the arms slowly outward away from the body and upward over the head as far as they will go. Hold them in this position for several seconds. This maneuver elevates the ribs and expands the chest, producing *inspiration*. Next slowly depress the arms toward the sides, and, when the chest is reached, the elbows are slowly and firmly depressed against it, expelling the air and producing an *expiration.* These motions should be repeated at the rate of ten to sixteen times a minute.

Breathing will begin in short gasps and will gradually approach the normal, but should no signs of breathing appear immediately do not be discouraged, as it may be established in seemingly hopeless cases after one to two hours' work.

Fig. 213.—Sylvester's method of artificial respiration. Expiration.

The Howard Method.—First place the patient face downward, with a large pillow or roll of clothing under his abdomen and chest, the forehead resting upon one arm. This position allows any fluids to flow from the lungs and also prevents the tongue from falling back into the throat. Firm pressure is made upon the left side and back for several seconds, or as long as any fluid escapes from the mouth. Then quickly turn the patient upon his back with a large roll placed under the shoulders. This causes the chest to protrude well forward, while the head extends downward and back. Secure the tongue by one of the methods mentioned above, and fasten the arms up over his head.

Kneel over the patient's hips, facing him, and place the palms of the hands with the fingers spread out upon each side of the chest, then slowly press forward and inward, using the weight of the body. This expels the air from the chest and produces *expiration*. Remain in this position several seconds, and then spring back, at the same time releasing the

Fig. 214.—Artificial respiration (Howard method).

chest wall and so producing an *inspiration*. Repeat these movements slowly, at first, and then at the rate of about sixteen times a minute.

Hall's Method.—The patient is placed face downward, with a roll of clothing under the chest, and steady, firm pressure is brought to bear between the shoulders with the hands, thus producing an *expiration*. Then, grasping him by one shoulder and hip, roll him on his side and back. This releases the chest and produces an *inspiration*.

By this method several assistants are required to manage the arms and legs.

Laborde's method consists of rhythmic tractions upon the tongue, and is carried out by grasping the tongue firmly with a pair of forceps or with the fingers covered by a cloth and alternately drawing it out and releasing it.

Drowning is a condition of asphyxia brought about by the failure of air to gain entrance to the lungs, the air-passages being blocked by water. There is a popular notion that a person has to sink under water to drown, but this is a mistake, as simply immersing the nose and mouth is sufficient to produce suffocation.

Fig. 215.—Expelling water from the stomach and lungs (Murray).

In cases of drowning there is some shock present, due to the prolonged exposure; and this may be so severe, combined with the weakness resulting from the prolonged struggle to keep afloat, that death results from heart failure before asphyxia occurs.

Treatment.—Remember that every minute and second are precious, so waste no time. Have all the bystanders move away so as to give the victim all the air possible. Loosen or remove the clothing from the patient's chest and neck and attempt to rid the air-passages of any water, mud, or mucus which may be present. Clear out the nose and throat, and pull the tongue well forward. Then turn the patient over, face downward, with a large roll of clothing under the abdomen, and, by making firm pressure upon the loins, any water will be expelled from the lungs and stomach. If the individual does not then breathe, do not waste any more time in these preliminaries, but hastily turn him upon his back and proceed with artificial respiration. At the same time try and stimulate respiration by having an assistant hold ammonia or smelling-salts to the nostrils. Remember, when turning the patient upon his back, to keep the tongue forward, as it is liable to fall back into the throat and block the air-passages.

In some instances the length of time breathing may be suspended is truly remarkable. Recovery from drowning has occurred where persons have been submerged from ten minutes to nearly an hour. Do not despair if resuscitation does not immediately follow. Cases have been reported where it has taken two hours to effect this.

When breathing has become established, carefully remove all wet clothing and wrap the patient up in warm, dry blankets, applying heat to the extremities. Restore the circulation by brisk friction applied to the limbs, and, as soon as he is able to swallow, give small quantities of hot coffee, whiskey, or brandy.

Hanging, or Strangulation.—Cut the person down immediately, if still suspended, and promptly remove any constriction from the neck. Remove the clothing from the chest and attempt to excite breathing by dashing cold water upon the face and body. If this fails, perform artificial respiration.

Choking.—It is a common accident as the result of foreign bodies or particles of food lodging in the throat. (For treatment, see under Foreign Bodies in Larynx.)

Asphyxia from Poisonous Gases.—Asphyxia may follow the inhalation of gases from the combustion of charcoal, coal, or coke. It may also result from illuminating gas, smoke, foul gases from sewers, wells, or mines, and from certain chemicals, as chlorine, chloroform, etc.

Treatment.—Remove the patient as quickly as possible to a pure atmosphere and attempt to resuscitate by artificial respiration.

In rescuing a person from the presence of poisonous or foul gases, there are some cautions to be observed. Never carry a light or strike a match in a room where gas has been escaping until the room has been thoroughly aired; likewise avoid carrying a light into a sewer, well, or mine, as the gases they contain are often inflammable. In rescuing a person from a room full of gas or smoke take a full breath and rush to the nearest window, which should be quickly raised or broken open. This will allow the rescuer to get a supply of fresh air, after which other windows and doors should be opened to create a draught and expel the gas. Before entering any foul atmosphere it is well to have the nose and mouth protected by a cloth or sponge saturated with water or vinegar.

FOREIGN BODIES IN THE EYE, EAR, NOSE, LARYNX, AND ALIMENTARY CANAL.

Foreign Bodies in the Eye.—Particles of dirt, sand, cinders, or fine pieces of metal are frequently blown into the eye and lodge there. They not only cause a feeling of discomfort, but, if not removed, set up an inflammation which is very painful as well as dangerous. Fortunately nature, through an increased flow of tears, dislodges most of these substances before any harm is done.

Treatment.—In no case should the eye be rubbed, as such a procedure is apt to drive any particles deeper into the tissues, and later it becomes a difficult matter to remove them. If the foreign body lodges under the upper lid, it may sometimes be removed by drawing the upper lid well down over the lower lid, and, as the upper lid returns to its normal position, its under surface will be drawn over the lashes of the lower lid, and any particles will be dislodged. Another method is to grasp the eyelid and turn it up over the tip of the finger, a match, or pencil, thus exposing its under surface, from which any particles may be carefully removed by means of the corner of a handkerchief, a camel's-hair brush, or a loop of fine wire.

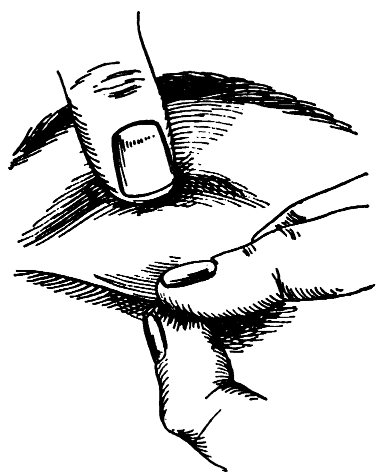

Fig. 216.—Preliminary step in everting the upper eyelid (Pyle).

Particles lodged under the lower lid may be removed in the same manner, simply pulling down the lower lid and exposing its inner surface.

Should a foreign body become firmly lodged in the substance of the eye, medical assistance must be sought.

Foreign Bodies in the Ear.—Small insects, ants, flies, or bugs may gain access to the ear. It is not a common accident, however, and is usually the result of sleeping or lying in the grass. Insects cause great discomfort by moving around, and it may be a difficult matter to dislodge them. Other bodies, as corn, beans, buttons, or small seed are often introduced into the ear by children. Such substances as seeds absorb moisture and are thus dangerous, as they swell up after entering the ear, making it a difficult matter to dislodge them, and they often produce a very painful inflammation.

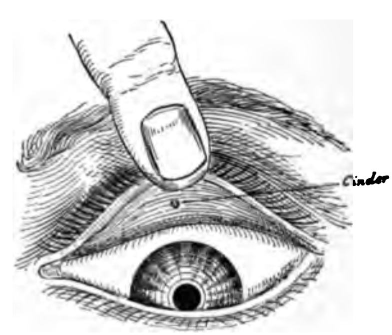

Fig. 217.—The upper eyelid everted (Pyle).

Treatment.—The only instrument that should be employed by one unskilled in such work is a syringe. *On no account should pins or pieces of wire be inserted into the ear to dislodge a foreign body.*

Insects may be killed by dropping a little sweet oil into the ear, and may then be removed by syringing out the ear with sweet oil or soap and water.

In the case of seeds, water cannot be used, but some liquid like alcohol, which will cause the body to shrink, should be employed. If syringing fails, attempt nothing more, but obtain medical aid.

Foreign Bodies in the Nose.—Foreign substances rarely remain long in the nose, as the violent sneezing they occasion is usually sufficient to dislodge them.

Treatment.—Encourage sneezing by means of snuff or irritation of the opposite nostril. Violent blowing of the nose, with one nostril closed, may dislodge the body. Should this fail, consult a physician.

Foreign Bodies in the Larynx.—Pins, coins, needles, fish-bones, false teeth, and particles of food often become lodged in the larynx or throat. While there is not, as a rule, a complete obstruction to the passage of air, symptoms of suffocation more or less severe are present—the victim's face becomes livid, he gasps for breath, and has violent fits of coughing.

Particles of food are frequently sucked into the larynx by a sudden inspiration while eating, so it should be remembered that it is a very dangerous thing to laugh while anything is in the mouth.

Treatment.—In all cases an attempt should immediately be made to remove the obstruction. Frequently by simply passing a finger into the throat the body may be felt and easily removed. Hence, in any case of asphyxia an examination of the throat should always be promptly made. Substances deeper down cannot be felt in this way, but may be dislodged by producing coughing or by slapping the person on the back. If this fails, the patient should be inverted, or literally stood on his head, with the hope of dislodging the body. If still unsuccessful, send immediately for a physician. In the meantime, if there is danger of asphyxia, perform artificial respiration.

Foreign Bodies in the Alimentary Canal.—Children or insane persons sometimes swallow pins, coins, nails, etc. They may lodge in the esophagus, producing difficulty in swallowing, but more often pass on into the stomach and appear later in the passages.

Treatment.—It is dangerous to attempt to dislodge the foreign body by producing vomiting. Avoid also giving purgatives, as they cause an increased movement of the intestines, and, in the case of a pin or sharp object, a perforation of this canal might result.

The best plan is to feed the person on bread and milk or mush for a day or two with the hope that the foreign body will become surrounded and be carried on into the intestines. Later, a mild laxative may be given.

CHAPTER XVIII.

UNCONSCIOUSNESS.

Unconsciousness, or coma, is simply a symptom of some other trouble, and at times it may be a difficult matter to ascertain its cause. Some of the more common conditions accompanied by unconsciousness are alcoholic intoxication, apoplexy, asphyxia, compression and concussion of the brain, convulsions, epilepsy, hysteria, certain forms of poisoning, shock, syncope, sunstroke, and uremic coma. To this list may be added a class of individuals who make a business of "throwing fits" to obtain a drink of liquor or a small sum of money which some sympathetic bystander will be sure to give them.

Examination of an Unconscious Person.—It will readily be seen how important a matter it is to always ascertain the cause of the condition before beginning any treatment, for it is obvious that the treatment of a case of opium poisoning, for example, must of necessity differ from that of a case of apoplexy. Hence a most careful and thorough examination of the patient should always be made.

Learn all you can from the bystanders as to the condition in which the patient was found, and whether he fell or received an injury. At the same time place him flat on his back, loosen all the clothing from the neck and chest, and, above all, provide plenty of breathing space by keeping the curious bystanders back.

The appearance of the patient should be carefully observed. Note whether the skin is livid and cyanotic in appearance, or pale and cold. A livid skin will be found as an accompaniment of apoplexy, epilepsy, forms of hysteria, and many other conditions. A pale, moist skin usually denotes concussion of the brain, shock, or hemorrhage. A very hot skin is a sign of fever or sunstroke.

Examine the head for the presence of wounds or fractures.

Notice whether the sufferer has convulsions, and examine the tongue to see if it has been bitten. Convulsions, especially epileptic, are liable to be accompanied by some injury to the tongue.

Smell the breath, but don't imagine that because it has an odor of alcohol that the person is necessarily simply intoxicated. He may have had a drink when he was taken sick or some one may have forced it down his throat while lying unconscious. Notice if the breathing is slow and labored, or fast. Noisy, snoring (stertorous) respirations, accompanied by flapping of the cheeks, usually denote apoplexy or some injury to the brain.

Notice whether the pulse is full and bounding, or rapid and weak. A full bounding pulse may indicate fever, apoplexy, or uremia; a rapid, weak pulse denotes shock; a very slow pulse is found in compression of the brain.

The eyes should always be examined, as they can give important information. Expose the pupils by gently lifting up the eyelids, and notice whether they are dilated (large) or contracted (small) and whether they are alike in size. When both pupils are much contracted, it is usually an indication of some narcotic poisoning. When one is dilated and the other contracted, it may be taken as an indication of some injury or pressure upon the brain. The depth of insensibility may also be judged by touching the clear portion of the eyeball with the finger. If totally unconscious, this will have no visible effect upon the patient; if partly unconscious, the individual will flinch or resent such a procedure by frowning.

Examination of the ankles should be made for swelling or edema; such a condition is usually an accompaniment of Bright's disease or uremic coma. The existence of edema may be discovered by forcibly pressing upon the part with the finger; if present, the imprint will remain.

The limbs should be carefully examined for fractures or indications of paralysis. It may appear a difficult matter to ascertain whether an unconscious person is paralyzed, but, by simply lifting the limbs and dropping them, it will be found that on the paralyzed side the limbs drop limp and as if dead, while on the other side they fall slowly. Do not make the mistake, which has been made, of pronouncing a limb paralyzed because it dropped limp, where, as a matter of fact, a simple fracture existed.

It should be remembered that sometimes only by a most careful and systematic examination can a correct diagnosis be made. By following the above suggestions serious mistakes may be avoided.

ALCOHOLISM.

The use of alcohol, if carried to excess, produces a condition of unconsciousness which is very apt to be confounded with other allied conditions. Too great care cannot be taken in examining these cases thoroughly, as mistakes are of frequent occurrence, and cases of fractured skull or apoplexy are often pronounced mere alcoholism. Do not be led astray by the fact that a person has an odor of liquor about him. He may have been drinking and had a stroke of apoplexy, or may in falling have fractured his skull. If there is the least doubt it is better to give the patient the benefit than to run any risks.

A person suffering from alcoholic coma lies in a stupor, but can usually be partially aroused and made to answer questions. The face is flushed, the pulse is full and rapid, and the respirations are deep. The pupils are usually dilated, and the breath has the heavy odor of alcohol.

Treatment.—Ordinary intoxication rarely requires any treatment besides rest and sleep. If the patient is in an exhausted state it is well to wash out the stomach or give an emetic, such as mustard and warm water. Then cover him warmly and apply heat to the extremities. If coma is present, try to arouse the patient by cold douching or striking with wet towels. If the pulse is weak, stimulants should be given; inhalations of ammonia, the internal use of strychnine or caffeine may be employed. The use of strong coffee by the rectum is of great service.

APOPLEXY.

Apoplexy is a condition of unconsciousness due to rupture of a blood-vessel of the brain, the resulting pressure from the blood-clot causing a loss of consciousness and paralysis. Apoplexy usually occurs in those past middle age. It is often the result of great mental excitement, although it may occur during sleep.

A person about to have an apoplectic fit may have warning by a slight dizziness, a feeling of pain in the head, or a numbness in the limbs; but, as a rule, the attack is abrupt; there is a sudden loss of consciousness and the patient falls to the ground. The face usually appears blue or cyanotic; the pupils are either equally dilated, or else one is dilated and the other contracted; the pulse is full and hard; the respirations are noisy, and with each expiration there is a flapping of the cheeks and a sputtering from the lips. There is usually paralysis of one side of the body, and the head or eyes may be turned to the opposite side. The unconsciousness is profound, and the patient cannot be aroused.

Apoplexy differs from alcoholism in the following respects: An individual suffering from apoplexy will be deeply unconscious: if suffering from alcoholism he can be aroused. With apoplexy the limbs on one side are usually paralyzed; with alcoholism no paralysis exists. In apoplexy the pupils are liable to be unequal; in alcoholism they are equal.

Treatment.—The treatment consists in absolute quiet and rest to prevent any further hemorrhage. Have the sufferer put to bed with the head slightly elevated; apply cold to the head by means of cold cloths or an ice-cap. Heat may be applied to the feet, *but avoid giving stimulants.* Of course, always summon medical aid.

CONCUSSION OF THE BRAIN.

Concussion of the brain, or contusion, as it is sometimes called, is a jarring or shaking up of the brain substance produced, as a rule, by falls or blows upon the head. Such an injury is always accompanied by more or less bruising of the brain substance.

Falling and "seeing stars" is a slight form of concussion which many of us have at some time experienced; or the jarring of the brain may have been more severe, leaving us weak, nauseated, and confused for some time afterward.

In the more severe forms of concussion the patient remains apparently unconscious, although he can be aroused and will answer questions, soon becoming drowsy again if left alone. The skin is pale and moist; the temperature is subnormal; the pulse is rapid and irregular; the respirations are frequent and shallow. The pupils respond to light and are either normal in size or else contracted. Patients, as a rule, react soon, but they may feel dizzy for some time after.

Treatment.—Place the patient flat on the back with the head slightly raised. Heat may be applied to the extremities and cold to the head, but *avoid the use of stimulants.*

COMPRESSION OF THE BRAIN.

Compression of the brain may be caused by blood-clot, bone (as in a fractured skull), or foreign bodies.

A person suffering from such an injury is in a state of total unconsciousness from which he cannot be aroused. The breathing is noisy as in apoplexy; the pulse is slow and full; the pupils are dilated or unequal and do not respond to light; the temperature of the body is generally subnormal. Paralysis of one side of the body is also a usual symptom.

Treatment.—The only means of treating compression of the brain is to remove its cause. In the absence of a surgeon, place the patient in a recumbent position with the head slightly raised. Should any wound be present, do not fail to apply some temporary dressing.

CONVULSIONS OF CHILDREN.

Convulsions in children may be due to beginning cerebral diseases, to reflex irritation, or may be symptoms of some acute sickness. Meningitis, cerebral hemorrhage, tumors of the brain, abscess of the brain, hydrocephalus, etc., are the most frequent diseases of the brain accompanied by convulsions. Worms, teething, indigestion, and severe injuries may be taken as examples of reflex irritation. Pneumonia, measles, scarlet fever, typhoid fever, etc., in children are often ushered in by convulsions. In a child, they have much the same significance as a chill has in an adult.

During a convulsion the child's body becomes rigid and stiff; the hands are clenched; the eyes are fixed or sometimes rolled up; the breathing is shallow and labored; and the face is first pale, later becoming livid and dusky. Convulsive movements and twitching of the face and limbs follow, or unconsciousness and stupor may result. Usually following the convulsions a condition of general relaxation with some evidence of collapse occurs; or the child may drop off into a quiet sleep.

Treatment.—Always send for medical aid. In the meantime, place the child in a warm bath and apply cold to the head, or the child's feet may be simply placed in a warm mustard bath with the body warmly covered. If convulsions reappear, the treatment should be continued.

EPILEPSY.

Epilepsy is a nervous affection accompanied by sudden attacks of unconsciousness, generally with convulsions.

Those subject to epileptic fits sometimes have a warning of an attack by an uneasy sensation and a feeling of apprehension, but more often the individual simply gives a sharp cry and falls to the ground in a convulsion. The jaws are fixed, the head is thrown back, and the hands are tightly clenched. The face is livid, and the pupils are dilated. A spasm of the muscles soon follows, which lasts for several minutes; the eyes roll and the eyelids alternately open and close. During a spasm the tongue may be caught by the teeth and be bitten. Frothing at the mouth is characteristic of epilepsy, the saliva being often blood-stained. The muscular spasm soon passes off, the muscles relax, and the patient regains consciousness, or else he remains in a semiconscious or stupid state for some time. Epileptics rarely have any recollection of having had a fit on regaining consciousness.

Treatment.—This should consist in preventing the sufferer from harming himself during a convulsion. The attacks are not dangerous, so simply loosen the clothing from the patient's neck and chest, and place something between the teeth to prevent injury to the tongue,—a cork or small piece of wood will answer for this purpose. If necessary have some one restrain the patient during the convulsion to prevent injury to the limbs. Following an attack the patient should remain quiet for some time.

HYSTERIA.

Hysteria is a disease of the nervous system accompanied by loss of control over the emotions. It usually is seen in women, but may also be present in nervous men. The disease is manifested in a great variety of ways, but the only form we shall consider is that accompanied by convulsions. In this form hysteria may closely resemble epilepsy.

The patients usually have an attack of laughing and crying, and gradually work themselves up to such an extent that they fall in a convulsion. The attacks are sometimes prolonged for several hours, and, upon recovery, it is not uncommon to find them laughing or sobbing for some time after. They appear to be unconscious, but in falling they always pick out some soft spot or chair to fall upon and are careful not to injure themselves. The tongue is rarely bitten in hysteria.

Hysteria may be mistaken for epilepsy, but in the latter condition the fall is sudden, and the sufferer frequently receives painful scalp wounds or injuries to the tongue.

Treatment.—While hysteria is a disease, the patient should nevertheless be treated with firmness. The subjects usually crave sympathy. To sympathize with such a patient is the worst possible thing and will simply prolong the attack or hasten another. The best thing to do is to leave the patients alone—of course seeing that no harm can come to them. When they recover and find themselves alone and without sympathy, they will not be so apt to repeat the attacks. In prolonged convulsions, throwing water in the face will usually terminate the seizure.

MALINGERERS.

Under this heading are included beggars who "throw fits" to obtain money from sympathetic persons, and other unfortunates who resort to such practices with the hope of obtaining a night's lodging in some hospital or, at least, a drink of liquor. These cases are frequently met with in the large cities and are the bugbear of the young ambulance surgeons. Mention of them is simply made as a warning against such impostors.

Many ingenious practices are resorted to in faking different kinds of fits. Epilepsy is more commonly faked, probably because it is easy to simulate this disease. With a small piece of soap held in the mouth the frothing characteristic of the disease is produced, and by twitching and holding the breath a condition so resembling epilepsy may be exhibited that at times it is difficult to detect the imposition. Malingerers, however, rarely go so far as to injure the tongue, and in falling they are careful to do themselves no harm.

SHOCK.

Shock, or collapse, may be defined as a condition of depression affecting the vital functions of the whole system. The action of the heart becomes weak and there is a dilatation of the blood-vessels of the internal organs, so that an accumulation of blood occurs in the interior of the body and the amount of blood circulating in the periphery is decreased.

Shock may be the result of great fear or grief. It may be due to hemorrhage, to injuries about the abdomen, to burns and scalds, to excessive cold, to gunshot wounds, or to severe lacerations and contusions,—in fact, any injury severe enough to produce a marked depressing effect upon the nervous centers will result in more or less shock.

A person suffering from severe shock lies in a drowsy condition, with the limbs limp, but is not totally unconscious. The skin is pale and cold; the temperature is subnormal; the pulse is feeble, fluttering, and rapid, and may be irregular and barely perceptible; the respirations are shallow and sighing; the pupils are generally dilated. Great thirst is frequently an accompaniment of shock, especially if caused by hemorrhage. The sensibility of these patients is often lowered, and they do not feel pain as acutely as in a normal condition.

Shock may result in immediate death from heart failure, or a condition, known as *reaction*, may be established. This state is frequently ushered in by vomiting and is characterized by a general return of color to the skin and a rise of the bodily temperature. There is an improvement in the heart's action, and the respirations become fuller and deeper. After reaction is established it is not unusual for the patient to fall into a sound sleep.

Treatment.—Cases of profound shock are most dangerous and require energetic treatment. The object should be to bring about reaction; the longer it is delayed, the worse is the outlook. The patient should be immediately put to bed, with the head lowered. Heat should be applied to the heart and extremities, and the body should be kept warmly covered with blankets. Friction applied to the limbs aids greatly in restoring the circulation. It is useless to give stimulants by the mouth until reaction has been established, as they simply remain in the stomach unabsorbed. A teaspoonful of brandy or whiskey or $\frac{1}{30}$ of a grain of strychnine may be given by hypodermic injection. Stimulating rectal enemata, consisting of half an ounce of whiskey to two pints of hot salt solution, are very valuable. In cases of shock from hemorrhage, the *stimulants should be omitted.*

When reaction is established, stop stimulating the patient and give hot coffee or hot fluids by the mouth in small quantities. Coffee is especially valuable in quenching the thirst which is so often present.

SYNCOPE.

Syncope, or fainting, is a condition of temporary unconsciousness due to a diminution of the supply of blood to the brain. This cerebral anemia, as it is called, may be the result of a great loss of blood whereby the supply to the brain is diminished, or it may be due to a sudden weakening of the heart's action from severe pain, fright, great mental excitement, or complete exhaustion. Fainting usually lasts but a short time and is not, as a rule, fatal. Women are more prone to it than men.

Before fainting, the individual may complain of feeling weak and dizzy and may have a roaring sound in the ears; at other times he becomes suddenly weak and falls in collapse. The pulse is weak, the respirations are rapid, and the skin is pale and clammy. The unconsciousness rarely lasts more than a few moments.

Syncope and shock resemble each other in many ways and are frequently confounded. Syncope is temporary, however, while shock is a more serious and permanent condition, usually following severe injuries. Shock is seldom accompanied by complete unconsciousness.

Treatment.—In most cases simply lowering the head will prevent fainting or will speedily relieve a person who has fainted. Lay the patient down flat on his back with the head lower than the feet, providing plenty of fresh air and removing all tight clothing from the neck and chest. This, combined with sprinkling cold water in the face or the application of smelling salts or ammonia to the nostrils, is generally sufficient to arouse him. When the patient is conscious and able to swallow, brandy or whiskey may be given in small amounts. The patient should remain quiet in the recumbent position for some time after recovering from the faintness.

SUNSTROKE.

Sunstroke is a condition produced by long exposure to great heat. Two forms are recognized: heatstroke and heat exhaustion.

Heatstroke (thermic fever, heat apoplexy) is due to exposure to the direct rays of the sun. Those affected are usually already debilitated or weakened by excessive drinking, though heatstroke may occur in healthy individuals who are compelled to labor hard while exposed to the effects of the sun.

The seizure may come on very suddenly, and the man be stricken down and die immediately. More often he first experiences a feeling of weakness and dizziness, combined with a sense of oppression. This is soon followed by unconsciousness. The breathing is rapid and labored, the pulse is weak and irregular, and the temperature is extremely high, at times reaching 106° to 110°. By simply placing the hand upon the man's body one can readily appreciate the high temperature. The pupils in these cases are usually contracted, and convulsions may occur. Should he recover, he is more susceptible to a second attack and afterward is unable to stand much exposure to heat without feeling exhausted.

Heat exhaustion is due to hard work and confinement in a close, hot atmosphere. The symptoms are those of collapse, the man first complaining of feeling tired and weak. The skin becomes pale and moist, the pulse is rapid and weak, and the temperature is usually subnormal.

The two conditions are easily recognized and should be readily differentiated. In heatstroke there is complete unconsciousness, and the body feels as if it were on fire; in heat exhaustion the patient is simply dazed, and the skin is pale, cool, and moist.

Treatment.—In heatstroke the object should be to reduce the temperature as rapidly as possible to the normal. This may be accomplished by the removal of the sufferer to a cool place and the free application of ice to the head and spine. If possible, remove the clothing and place the patient in a cold bath, at the same time rubbing the body briskly to bring the overheated blood to the surface. (See Cold Bath, page 155.)

In heat exhaustion usually all that is required is rest and the use of stimulants. If the temperature is below normal, cover the body warmly with blankets and apply heat to the extremities.

UREMIC COMA.

Uremic coma, or uremia, results from a diseased condition of the kidneys, with retention in the body of certain poisonous materials which should be normally excreted. It is a common accompaniment or termination of Bright's disease.

The condition may be ushered in by symptoms of headache, dizziness, and spots before the eyes, soon followed by convulsions and total unconsciousness. Usually the temperature is subnormal; the pulse is slow and full, or rapid and bounding; the pupils are small; the skin is dry, and there is an odor of urine to it and the breath. The patient's appearance is also characteristic. He is pale and has a bloated look, with swelling about the face and eyelids and edema of the ankles.

Treatment.—This is a very serious condition and needs prompt attention. In the absence of a physician, give a purgative if the patient is conscious, and attempt to excite the skin to action through sweating. This may best be effected by giving a hot pack (page 157). A hot bath, followed by closely surrounding the body with warm blankets and plenty of hot bottles, may accomplish the same result.

CHAPTER XIX.

POISONING AND ITS TREATMENT.

A poison, as commonly understood, is any substance which if taken in small quantities will injure the health or produce death.

Many cases of poisoning by such substances are the result of their being taken with deliberate intention, but the cases occurring from carelessness or mistake are of such frequent occurrence as to call forth needed censure upon the manner in which many people handle poisons. In the newspapers every little while one may read of cases of children dying by drinking some deadly poison left within reach, or of adults who have accidentally taken poison through mistaking it for something else. Cases like the former are bound to occur as long as people continue to be careless, but to avoid the latter, all bottles or boxes containing any drug should be clearly labelled, and anything as to the nature of which there is any doubt should be thrown away. Furthermore, poisonous drugs should always be kept in bottles of such peculiar form or shape that a person's attention would be immediately attracted on taking hold of them. In most hospitals such drugs are kept in bottles the external surfaces of which are studded with small shot-like knobs, giving them such a roughened feel that they cannot be mistaken for anything else, even in the dark. Another good method is to pass several small pins transversely through the cork of the bottle so that the pointed ends project out beyond the cork on the opposite side. On attempting to remove such a cork, a person will immediately become aware that he has not an ordinary bottle in his hands.

Classification of Poisons.—Poisons are divided, according to their action, into neurotics, irritants, and corrosives.

Neurotics produce their effect upon the nervous system; they seldom have any local effect, acting only after being absorbed into the circulation. Some produce sleep, stupor, and coma (narcotics); some intoxication (inebriants); some insensibility (anesthetics); some spasms (convulsives); and others cause faintness or marked depression (depressants). To this class belong opium, chloral, aconite, belladonna, alcohol, hemlock, chloroform, hyoscyamus, nicotine, prussic acid, strychnine, and poisonous fungi.

Irritants produce a burning sensation in the stomach, followed later by an inflammation of that organ; some time elapses, however, before the symptoms appear. The chief irritants are arsenic, antimony, cantharides, phosphorus, salts of copper, mercury, zinc, dilute acids, and tainted foods.

Corrosives have a marked local action, destroying all tissues with which they come in contact. They leave a metallic taste in the mouth and produce a burning pain in the throat and stomach. The symptoms come on promptly and are accompanied by collapse. Mineral acids, caustic alkalies, oxalic acid, carbolic acid, and corrosive sublimate belong to this class.

The above classification is in accordance with the most characteristic action of the drugs, but some of these poisons may have a combined action; nicotine, for example, is both an irritant and neurotic poison.

General Treatment of Poisoning.—*Always send for medical aid promptly.* In the meantime learn, if possible, what substance has been taken and whether the person is really suffering from poisoning. As a general rule poisoning is characterized by suddenness in onset and by the appearance of its characteristic symptoms of pain, vomiting, and collapse within a short time after a person, apparently healthy and in good condition, has taken something into the stomach. In the treatment bear in mind the following directions:

1. *Empty the stomach of the poison as quickly as possible.*
2. *Neutralize what cannot be removed.*

3. *Counteract the depressing effects of the poison.*

To Empty the Stomach.—This may be accomplished by means of a stomach-pump, or stomach-tube, or by the use of emetics.

The *stomach-pump* consists simply of a rubber tube, long enough to reach into the stomach, with a funnel at one end, and near the funnel end a suction-bulb, such as is seen in an ordinary rubber syringe. By alternately squeezing and relaxing the bulb, the contents of the stomach are sucked up and forced out.

A stomach-tube is the same, without the suction-bulb; one may be readily improvised by taking a piece of rubber tubing, five or six feet long, and somewhat larger than a lead pencil, and placing a funnel at one end. To pass the tube into the stomach, first see that the tube is well oiled. Then guide it directly back along the posterior wall of the pharynx as far as possible, from which point it should be slowly pushed into the stomach. The person will probably gag a good deal, but, if conscious, he may be able to materially aid the passage of the tube by being instructed to swallow occasionally. Should the tube get into the air-passages, we will become aware of that fact by violent coughing and the escape of air from the funnel end. *Always be on the lookout for this and make sure of the location of the tube before pouring any solution into it.* In cases where the jaws are tightly closed or the patient tries to prevent the passage of the tube by biting it, do not waste time in attempting to get it into the mouth, but pass it through the nose. When the tube is in the stomach, one or two quarts of warm water should be poured into the funnel. The end of the tube is then pinched, and upon lowering it, the contents of the stomach are drawn off by the siphonic action. The washing out process is to be repeated until the fluid returns clear.

Emetics are drugs which have the property of producing vomiting. Of the more common emetics these may be mentioned:

Sulphate of zinc (white vitriol); twenty grains may be given in half a glass of warm water.

Copper sulphate; give ten grains in half a glass of warm water.

Ipecac; give about fifteen grains of the powder or two tablespoonfuls of the wine in half a glass of water.

Apomorphine; it is given hypodermically in the dose of $\frac{1}{16}$ grain.

Mustard; a teaspoonful in half a glass of warm water is an excellent emetic and usually available.

Plain warm water, or a tablespoonful of salt to a glass of warm water, also act as emetics.

In some cases, when unable to procure a stomach-tube or emetics, the stomach may still be washed out by having the patient drink a quantity of tepid water, and then producing vomiting by irritation of the throat with a feather or the finger.

In cases of poisoning by corrosives, the *stomach-tube or emetics should not be used.*

To Neutralize the Poison.—For this purpose the proper antidote should be given. Antidotes are substances which render poisons inert and counteract their ill effects; they may be given by the mouth or through the stomach-tube after washing out the stomach. Antidotes are spoken of as chemical or physiological.

Chemical antidotes are substances which, if brought in contact with poisons, exert a direct chemical action upon them, either destroying their poisonous properties or changing them into such a form that they are harmless.

Physiological antidotes have no direct action upon poisons, but, when taken into the system, have an action which is antagonistic to that of the poison and produce symptoms which are directly the opposite to those produced by the poison.

The proper antidotes will be found under each special poison.

To Counteract the Depressing Effects of the Poison.—Stimulants should be used freely and are especially indicated in narcotic poisoning. They may be given by the mouth, hypodermically, or by the rectum. Brandy, whiskey, or strychnine are to be given when there is great collapse. Strong coffee given by rectal enema is most useful in some cases. Heat or mustard plasters should be also applied to the heart and extremities when collapse is threatened. In poisoning from corrosives or irritants, pain is a prominent symptom. It may be controlled by giving one-quarter of a grain of morphine hypodermically or fifteen to twenty drops of laudanum in water by mouth. These doses are suitable for adults; for children much smaller amounts should be given, depending on the age.

THE TREATMENT OF SPECIAL FORMS OF POISONING.

ACIDS.

Strong **mineral acids,** as hydrochloric (muriatic or spirits of salt), nitric (aquafortis), and sulphuric (oil of vitriol).

They are all corrosives and cause a great destruction of tissues.

Symptoms.—Staining of the mouth and lips is produced,—nitric acid leaves a yellow or lemon-colored stain and sulphuric acid a black stain. The victim experiences a burning sensation or pain extending from the mouth to the stomach directly the poison is swallowed. This is soon followed by swelling of these tissues which renders swallowing very difficult. Vomiting occurs, and there is marked shock and collapse, accompanied by a cold, moist skin.

Treatment.—Do not give emetics or use the stomach-pump. *Alkalies are antidotes for acids,*—lime-water, baking-soda, magnesia, chalk, crayons, plaster from the walls, whitewash, or soap should be given immediately. Follow by the use of the whites of eggs and milk, olive oil, castor oil, or some mucilaginous drink. Stimulants may be given by the rectum or hypodermically.

Vegetable Acids, as acetic, oxalic, and tartaric.

Symptoms.—They produce a burning pain in the mouth, a feeling of constriction about the throat, and are followed by shock and prostration.

Treatment.—In the case of tartaric or acetic acid use any of the alkalies mentioned above. In oxalic-acid poisoning use only chalk or lime-water.

Carbolic Acid (phenol) or **Creosote.**—The former is one of the most deadly and rapidly acting poisons known.

Symptoms.—The same symptoms as in any acid poisoning may be met with, or there may be sudden unconsciousness and death from collapse. An odor of the acid can usually be detected upon the breath, and white eschars are present upon the lips. If a person survives long enough, the urine becomes greatly decreased in quantity and is cloudy or black in appearance.

Treatment.—*The antidote is alcohol* or *some soluble sulphate*, as Epsom or Glauber salts. Later, give the whites of eggs, olive oil, or castor oil. Collapse is a prominent symptom and should be properly treated.

Hydrocyanic Acid (prussic acid) is a transparent, colorless liquid with an odor like that of bitter almonds. It is present in potassium cyanide, laurel, laurel-water, peach- and cherry-pits, and the oil of bitter almonds. Hydrocyanic acid is a very deadly poison, one drop of the pure acid being sufficient to produce death.

Symptoms.—The action of the poison is almost instantaneous. Occasionally the person may first feel a constriction about the throat and some giddiness, but generally he falls insensible and lies with eyes fixed and staring. The face is cyanotic and livid; the body feels cold and the skin moist; the teeth are tightly clenched; and there may be frothing at the mouth. Violent convulsions follow, and the respirations become slow and weak. Death occurs from respiratory paralysis.

Treatment.—There is no chemical antidote. Emetics or the stomach-pump should be immediately employed if there is time; otherwise proceed with artificial respiration and give inhalations of ammonia. Stimulate freely, apply friction to the extremities, and pour cold water over the head and spine.

ACONITE.

(Monk's-hood, Wolfsbane, Blue Rocket.)

Aconite is used extensively in fever mixtures, ointments, and liniments.

Symptoms.—They come on promptly, and consist of a burning and tingling sensation in the mouth and throat, soon followed by numbness. The skin becomes cold and moist; profuse sweating occurs; the pupils are dilated, and the eyes are fixed; the pulse is weak and irregular; the gait is staggering, due to the loss of muscular power; great difficulty is experienced in breathing; and vomiting may be present. Death is usually due to asphyxia or collapse.

Treatment.—Place the patient in a recumbent position with the head low and the feet slightly raised. Employ emetics or the stomach-pump promptly. Allow the patient to make no unnecessary movements, as the slightest exertion is liable to be followed by collapse. Apply heat to the extremities. Stimulants should be given freely; a teaspoonful of brandy or whiskey, strychnine gr. $\frac{1}{30}$, or atropine gr. $\frac{1}{120}$, may be given hypodermically. The use of strong coffee by the rectum is advisable. If necessary, artificial respiration should be resorted to.

ALKALIES.

Caustic alkalies have the same effect as acids, producing a destruction of the tissues with which they come in contact. Poisoning from these agents is not common, and is usually due to caustic soda, caustic potash, lime, lye, pearlash, or strong solutions of ammonia.

Symptoms.—Strong alkalies produce marked pain and swelling of the lips and mouth, which is soon followed by a burning pain in the throat and abdomen. Vomiting, difficult breathing, a rapid, feeble pulse, and collapse, manifested by a cold, moist skin, ensue.

Treatment.—Do not give emetics or use the stomach-pump. *Weak acids are the antidotes for alkalies;* give lemon-juice, orange-juice, vinegar, or *dilute* hydrochloric, citric, acetic, or tartaric acids. Later, the whites of eggs, castor oil, linseed oil, olive oil, or flour and water should be administered. Follow by the use of stimulants.

ANTIMONY.

Some of the compounds of antimony, as tartar emetic, act as irritants, but the chloride, or butter of antimony, acts as a corrosive.

Symptoms.—A metallic taste is left in the mouth, soon followed by a feeling of nausea and weakness. Vomiting of the most violent character is present, the vomited matter containing first the contents of the stomach and later blood. At the same time there is violent purging and diarrhea, which speedily reduces the sufferer to a state of collapse. The skin becomes cold and moist; the face is pinched and covered by a profuse sweat; the pulse becomes weak and thready; and the respirations are faint. Cramps may be present in the legs, and there is great thirst.

Treatment.—*The antidote is tannic or gallic acid*, given in large quantities; strong tea or an infusion of oak bark, which contains tannic acid, may be substituted, if the above drugs are not available. Use the stomach-pump, if the contents of the stomach have not been completely expelled; keep the patient in a recumbent position, and apply external heat. At signs of collapse employ free stimulation.

ARSENIC.

(White Arsenic, Arsenous Acid.)

Arsenic is often present in colored wall-paper, painted toys, and some colored candies; it is also an ingredient of corn-cures and rat-poisons. Paris or Schweinfurt green and Scheele's green are compounds of arsenic and copper.

Symptoms are those of an irritant poison. There is a feeling of faintness and a burning pain in the pit of the stomach.

Vomiting and purging are present, the stools being tinged with blood and in appearance like rice-water. The expression is anxious, and the face drawn. Frequently there is a severe frontal headache. There may be cramps in the legs, and the extremities are cold.

Treatment.—Give emetics promptly or use the stomach-pump. *As an antidote, raw eggs beaten in milk, or freshly precipitated ferric hydrate with magnesia,* commonly known as "arsenic antidote," may be employed; magnesia alone may be used. Follow by the use of large doses of castor oil and water, olive oil, or sweet oil. Stimulate the patient if necessary, and apply heat to the extremities.

BELLADONNA.

(Deadly Nightshade.)

Belladonna is an ingredient of many ointments and liniments. The active principle, atropine, is prescribed in eye-lotions.

Symptoms.—Belladonna causes a decrease in the quantity of nearly all fluids secreted by the body. As a result, the mouth and throat become very dry and difficulty is experienced in swallowing. The skin is flushed and dry, the pupils are widely dilated, vision is often double, and the pulse becomes very rapid. These symptoms are followed by dizziness, a staggering gait, and at times by delirium and convulsions.

Treatment.—Empty the stomach, and treat the collapse by heat to the extremities and the use of stimulants. Artificial respiration may be necessary. Morphine may be given in small doses as the physiological antidote.

CAMPHOR.

(Gum Camphor, Laurel Camphor.)

Camphor is an ingredient of spirts of camphor, cough-mixtures, and many liniments.

Symptoms.—Poisonous doses cause excitement, giddiness, and headache. There is a burning pain in the stomach, and frequently the odor of the camphor may be detected upon the breath. Delirium and convulsions often occur. Collapse, with a small, weak pulse, is the usual termination.

Treatment.—Empty the stomach, apply heat to the extremities, and stimulate if collapse occurs.

CANNABIS INDICA.

(Indian Hemp, Haschisch, Ganga.)

This drug is used extensively in Eastern countries for its pleasant effects.

Symptoms.—There is a feeling of exhilaration and intoxication, and the mind is filled with pleasant ideas. The eyes are bright, and the pupils dilated; the limbs feel heavy, and sensibility is diminished. These symptoms are followed by a profound sleep.

Treatment.—There is no antidote. Empty the stomach and try to arouse the patient.

CANTHARIDES.

(Spanish Flies, Blister Beetles.)

Cantharides is a powerful irritant, and is used chiefly as a counterirritant or blister.

Symptoms.—There is an intense burning pain in the mouth, followed by vomiting and purging. The drug causes an inflammation of the kidneys and genitourinary tract, manifested by an increased desire to urinate; the urine may be blood-stained. Convulsions often occur.

Treatment.—There is no antidote. Empty the stomach and give such mucilaginous drinks as egg and milk, arrowroot, flaxseed tea, or flour and water.

CHLORAL HYDRATE.

(Chloral.)

Chloral is an ingredient of many sleeping mixtures; it is also present in "knock-out drops."

Symptoms resemble those of opium-poisoning. The surface of the skin is cold; the face is livid; the pulse is slow and feeble; the breathing becomes greatly diminished in rapidity; the pupils at first are contracted, but later may dilate. These symptoms are accompanied by muscular relaxation. The patient finally sinks into coma, which becomes so profound that it is impossible to arouse him.

Treatment.—Empty the stomach. Place the patient in the recumbent position with the head low; apply heat to the limbs; and stimulate with strychnine, brandy, or whiskey, or give hot coffee by the rectum. Perform artificial respiration, if necessary, and attempt to arouse the patient by shouting, striking with a wet towel, or douching with cold water.

CHLOROFORM.

Chloroform is taken internally in the form of the spirits or water of chloroform. It is also an ingredient of many cough-mixtures and liniments. Cases of poisoning from its being taken internally are rare.

Symptoms.—There is an odor of the drug upon the breath. It produces a burning sensation about the lips, mouth, and stomach. Dizziness, staggering, symptoms of collapse, and unconsciousness soon follow.

Treatment.—Empty the stomach. Then give bicarbonate of soda and water, and attempt to arouse the patient by cold douching, etc.

CHLOROFORM, ETHER, AND NITROUS OXIDE (Inhaled).

Symptoms vary according to the stage of anesthesia. After its prolonged use, or when a dangerous point is reached, the patient's respirations become embarrassed; the pulse becomes weak, fast, and irregular; the face is pale or livid; the pupils dilate; there is a loss of sensibility in the conjunctivæ and a complete relaxation of the limbs.

Treatment.—Remove the clothing and place the patient on his back with the head low and the feet elevated. Provide plenty of fresh air. See that the tongue is pulled well forward, and remove any mucus from the throat. If this is neglected, respiration is apt to be interfered with. Perform artificial respiration, and stimulate freely. Attempts should be made at intervals to arouse the patient by shouting or slapping with wet towels.

COLCHICUM.

(Meadow Saffron.)

Colchicum is used in the treatment of gout and rheumatism.

Symptoms.—There is profuse vomiting and purging, the latter accompanied by severe colic. Prostration and collapse finally supervene. Severe cases are hopeless and death is said to be slow and painful.

Treatment.—*Use tannic acid* or *very strong tea as an antidote.* Empty the stomach and give mucilaginous drinks. Then apply heat to the heart and extremities, and stimulate freely.

CONIUM.

(Hemlock.)

Symptoms.—There is muscular weakness and loss of control over the limbs. The patient staggers on attempting to walk; the legs feel heavy; the arms fall powerless. Vision is often disordered; the eyelids drop and the pupils dilate. Respiration becomes difficult. Death finally occurs from asphyxia.

Treatment.—Rid the stomach of its contents and give tannic acid or strong tea. Stimulate with strychnine, and apply heat to the heart and extremities. If necessary, employ artificial respiration.

COPPER.

The salts of copper, as the sulphate (blue vitriol, blue stone) or the subacetate (verdigris), in large quantities are very poisonous. Canned fruit contaminated with copper salts and food cooked in a copper vessel are liable to produce poisoning.

Symptoms are the same as other irritants. There is a metallic taste in the mouth and a burning sensation in the stomach, soon followed by vomiting, the vomited matter being green; diarrhea and colicky pains in the abdomen occur. Finally, the sufferer is attacked with convulsions.

Treatment.—*Potassium ferrocyanide is the antidote*, but some form of albumin, as the white of eggs, which forms an inert compound with copper salts, may be given. Follow by the use of linseed oil, sweet oil, or flour and water. The later treatment consists in giving full doses of potassium iodide.

CORROSIVE SUBLIMATE.

(Bichloride of Mercury.)

Corrosive sublimate is used extensively as a disinfectant and antiseptic. It is a mild corrosive.

Symptoms.—There is a metallic taste in the mouth; the lips and tongue may be stained white; cramps and colicky pains are felt over the abdomen, soon followed by vomiting and purging. The skin becomes cold and moist, and other symptoms of collapse are present.

Treatment.—Emetics may be given. *Albumin or the white of eggs acts as an antidote.* Later, give mucilaginous drinks and full doses of potassium iodide. Stimulate freely at signs of collapse.

CROTON OIL.

This is one of the most powerful irritants known. It is a pale yellow fluid resembling castor oil, but has a burning taste.

Symptoms.—After a poisonous dose violent vomiting and purging, with severe pain and cramps in the abdomen, occur almost immediately. This is followed by a rapid collapse.

Treatment consists in the prompt use of emetics, followed by giving the whites of eggs or milk and flour. Stimulate the patient freely. Morphine may be required for the relief of the pain.

DIGITALIS.

(Foxglove.)

Digitalis is used as a heart stimulant. It is cumulative in its action,—that is, after its long-continued use sudden symptoms of poisoning may occur without any increase in the amount taken.

Symptoms.—The effect of this drug upon the heart is characteristic. The pulse at the wrist may be slow and full, or may not be perceptible at all, and yet the heart will be heard beating tumultuously and out of all proportion to the pulse-rate. This is due to the direct action of the drug upon the heart muscle. Headache is a prominent symptom. Digitalis is a mild irritant, and nausea, vomiting, colicky pains, and cramps may occur. The skin is pale and collapse soon follows, the patient remaining conscious to the end.

Treatment.—*Tannic acid is the chemical antidote.* Empty the stomach, if the drug has been taken in one large dose, and give tannin, strong tea, or oak bark. Apply heat to the limbs, and keep the patient in the recumbent position. Aconite may be used as the physiological antidote.

HOLLY BERRIES.

These berries are eaten with impunity by birds and animals, but with human beings they act as irritants.

Symptoms are those of other irritants,—vomiting, purging, cramps, and colic. Unconsciousness may follow.

Treatment.—Give emetics and apply heat to the extremities. Stimulate the patient if necessary.

HYOSCYAMUS.

(Henbane.)

Symptoms.—An overdose of hyoscyamus may produce in some individuals deep sleep and unconsciousness, in others a feeling of excitement and giddiness, followed by noisy delirium and coma. The pupils are dilated and the vision may be double. Thirst is also a prominent symptom.

Treatment.—Give emetics, and stimulate if necessary. Strong coffee by the rectum is useful where there is coma. Large doses of castor oil should be given later.

IODINE.

Symptoms.—There is pain and a burning sensation in the throat, followed by vomiting and purging. The drug leaves a yellow stain about the mouth, and the vomited matter may be yellow or blue.

Treatment.—*The antidote is starch.* Empty the stomach and give starch and water; thin boiled starch-paste is better if there is time to prepare it. Follow by the use of stimulants and the whites of eggs beaten up in milk.

IODOFORM.

Iodoform is used extensively as an antiseptic in dressing wounds, and is readily absorbed from cut surfaces. In some susceptible persons, after its prolonged use, very alarming symptoms of poisoning may occur.

Symptoms may be mild, consisting only of a feeling of weakness with headache and nausea. In other cases there may be a most severe gastrointestinal irritation. Usually an eruption appears upon the skin in the form of a redness or inflammation. There may be loss of memory, insomnia, and melancholia, or symptoms of great mental excitement, consisting of hallucinations and even mania, may occur.

Treatment.—Stop the use of the drug immediately. Then attempt to hasten its elimination by wrapping the patient up in hot blankets or sponging with warm water to produce sweating. Alcoholic stimulants should be given, if necessary.

LEAD.

Chronic lead-poisoning is common in painters. Acute poisoning is rare, however, and is generally due to taking paint, red lead, white lead, Goulard's extract, or sugar of lead.

Symptoms.—Lead leaves a sweet, metallic taste in the mouth and a dryness in the throat, soon followed by pain in the abdomen accompanied by vomiting and purging, the vomited matter usually being milk-white in color. The pulse becomes rapid and weak, and the face anxious. There are cramps in the limbs, followed in some cases by convulsions, coma, and death.

Treatment.—*The antidote is Epsom or Glauber salts.* Empty the stomach and give the antidote. Follow by the use of the whites of raw eggs and castor oil. Apply heat to the extremities and abdomen.

MUSHROOMS.

(Fly Fungus.)

There are many varieties of mushrooms which are innocuous, while others are extremely dangerous, containing a poison called *muscarine*. It is popularly supposed that a piece of silver or an onion will change color if cooked with a poisonous mushroom, or that cooking mushrooms with vinegar added to the water will destroy the poison. These ideas are fallacious, as no such general rules will apply to all species.

In an excellent article by Porcher in "The Reference Handbook of Medical Sciences" the following rules are given for selecting mushrooms:

1. "Every mushroom should be rejected, whatever its species, which is too old, or with perforations which show the presence of maggots.

2. "All of which the texture is woody.

3. "All those the taste of which is acrid, burning, bitter, acid, or peppery. Although some are edible which are either acrid, or peppery.

4. "All those which exhale a disagreeable and nauseous odor; which are slimy and deliquescent.

5. "The following is an indication of danger: the presence of a bulb or swelling of the base of the stem, it being surrounded by a volva, or white envelope, in the form of an eggshell, and remaining as a socket at the base when the mushroom is pulled up; a collar or ring, large and reflected, or falling back; lastly, the head covered with the *débris* of the volva and made scaly and warty, as in *Amanita muscaria*. In the poisonous, the scales or protuberances rub easily off, leaving the skin intact."

Symptoms may come on in a few moments or in several hours, and consist of nausea, vomiting, colic, and diarrhea. The pulse becomes weak; the breathing is labored; the body is covered with a profuse perspiration; the pupils are at first contracted and later dilated. These symptoms are followed by collapse and muscular weakness, and there may be paralysis.

Treatment.—Empty the stomach and apply warmth to the abdomen and extremities. Stimulate freely, and later give large doses of castor oil. Atropine may be used as the physiological antidote.

OPIUM.

Opium is present in morphine, laudanum, black drop, Dover's powder, paregoric, chlorodyne, and in many soothing-syrups and sleeping-cordials.

Symptoms.—The individual experiences a feeling of contentment, which is soon followed by drowsiness and a tendency to fall asleep. The sleep is profound, and, unless aroused, the patient gradually lapses into coma accompanied by such a deadening of the sensibility that it is impossible to awaken him. The skin is pale and moist or livid; the respirations are labored, noisy, and very slow, often dropping as low as four or five to the minute; the pupils fail to respond to light and are very much contracted, at times as small as pin points. This is one of the characteristic signs of opium poisoning. Convulsions may precede death, which usually is due to asphyxia.

Treatment.—*Potassium permanganate is the chemical antidote.* Empty and wash out the stomach, using a weak solution of potassium permanganate for the latter purpose. Keep the patient aroused by slapping with wet towels, by cold douching, or by giving inhalations of ammonia, and walk him about, if possible. *To allow the patient to sleep is fatal.* Give plenty of strong coffee by the mouth or, if unconscious, by the rectum in an enema. If the breathing becomes labored, perform artificial respiration. Atropine may be given as the physiological antidote.

PHOSPHORUS.

Phosphorus is present in matches and some rat-poisons.

Symptoms.—It leaves a taste of garlic in the mouth, while the breath has an odor of phosphorus. The symptoms may not come on at once. A sensation of heat and burning is first experienced about the stomach, followed by vomiting, the vomited matter being tinged with blood and luminous in the dark. The pulse becomes weak; the pupils are dilated; and there may be headache, delirium, muscular twitching, and convulsions. Collapse soon follows. Should the sufferer survive, jaundice and hemorrhages from the nose, stomach, and mucous membranes occur.

Treatment.—*Old French oil of turpentine is an antidote,* but any other oils or fats should be avoided, as they aid in the absorption of the poison. Empty the stomach, and follow by giving magnesia or chalk and mucilaginous drinks.

POKE BERRIES.

(Phytolacca Fruit.)

Symptoms.—In small doses they act as irritants, producing nausea, vomiting, and purging. In large doses they have a narcotic action which is slow and protracted. Convulsions and coma may occur.

Treatment.—Empty the stomach and give castor oil; follow by mucilaginous drinks; stimulate if necessary.

PTOMAINE.

(Food Poisoning.)

During the putrefaction of animal and vegetable matter, certain injurious substances called *ptomaines* are produced which give rise to serious symptoms if taken into the system. Poisoning from eating tainted meat, fish, lobsters, clams, milk, and cheese are included under this head.

Symptoms.—Usually a few hours after taking the food there is a feeling of nausea followed by retching, vomiting, abdominal pain, and faintness. Purging may also occur. Marked prostration, manifested by a cold, moist skin and weak pulse, soon follows. The pupils are dilated. Thirst and muscular weakness are prominent symptoms, and even convulsions and delirium may occur. In some individuals a redness of the skin or a scarlet rash is produced.

Treatment.—Empty the stomach, give stimulants, and apply heat to the abdomen and extremities. Later, give large doses of castor oil.

SILVER NITRATE.

(Lunar Caustic.)

Acute poisoning is rare, but it has occurred from sticks of silver nitrate being broken off and swallowed during cauterization of the throat.

Symptoms are those of a corrosive,—pain and burning in the throat and abdomen, and gastrointestinal irritation. The mouth will be stained white.

Treatment.—*Salt is the antidote.* Give emetics, followed by salt and water.

STRAMONIUM.

(Thornapple, Stink Weed, Jamestown Weed.)

Stramonium resembles belladonna in its action and the symptoms it produces. (See Belladonna, page 287.)

STRYCHNINE, NUX VOMICA.

(Poison Nut, Dog Button, Quaker Button.)

Strychnine is the active principle of nux vomica, it is also present in St. Ignatius bean.

Symptoms.—The effect of the poison may be manifested by a sudden spasm of the muscles which throws the individual off his feet, or there may first be a feeling of suffocation, difficulty in breathing, and a sensation of stiffness about the neck. This is soon followed by convulsions affecting nearly all the muscles at once. The head is drawn back and the body is held rigidly arched forward, so that the sufferer practically rests upon his head and his heels; the eyes are open and staring; the corners of the mouth are drawn back, giving an appearance of laughing (*risus sardonicus*). During the convulsions there is great difficulty or even inability to breathe. A convulsion will last a few moments and then pass off, leaving the sufferer weak and exhausted; the slightest noise or touch is liable to bring on another convulsion. Eventually the convulsions follow one another in rapid succession, and death results from asphyxia or exhaustion.

Strychnine-poisoning resembles lock-jaw (tetanus), but can be distinguished from it by the fact that in tetanus there is rarely any complete muscular relaxation, while in strychnine-poisoning there is a distinct period of intermission between the convulsions. Again, in tetanus locking of the jaws is one of the early symptoms; in strychnine-poisoning it comes late.

Treatment.—*Tannin or charcoal are the antidotes.* If the sufferer is seen early, before the convulsions occur, empty the stomach and give tannic acid, charcoal, strong tea, or an infusion of oak bark. Inhalations of amyl nitrite or chloroform should be given to control the convulsions, while large doses of chloral and bromides should be given by the rectum. It may be necessary to perform artificial respiration.

TOBACCO, NICOTINE.

Nicotine, the active principle of tobacco, will produce poisoning if taken internally.

Symptoms.—The symptoms are those of gastrointestinal irritation with those of collapse. There is a burning in the mouth, throat, and abdomen, followed by nausea and vomiting; the pulse is rapid and feeble; the respirations are labored; the pupils are contracted. Intense muscular weakness, convulsions, and coma rapidly follow.

Treatment.—Employ emetics or the stomach-pump; *give tannic acid in some form as an antidote;* keep the patient in a recumbent position, and apply heat to the abdomen and extremities. As the physiological antidote, strychnine may be employed. Perform artificial respiration if needed.

ZINC.

Zinc salts, as the sulphate (white vitriol) and the chloride (butter of zinc), are extremely poisonous in large doses. Certain soldering fluids also contain zinc.

Symptoms.—It is an irritant in its action, producing pain and burning of the throat and abdomen, vomiting, purging, colicky pains, and collapse.

Treatment.—Empty the stomach, and give bicarbonate of soda, the whites of eggs, strong tea, or tannic acid. Apply heat to the abdomen and limbs, and stimulate if need be.

For hasty reference the following résumé of the immediate treatment in cases of poisoning is given:

Poison.	Treatment.
Acids	*Alkalies are antidotes.* Give chalk, lime-water, magnesia, etc. Follow by mucilaginous drinks. Give stimulants if necessary, and opiates for pain.
Aconite	Empty the stomach. Stimulate freely. Keep patient quiet.
Alcohol	Empty the stomach and arouse the patient by cold douching.
Alkalies	*Weak acids are antidotes.* Give lemon-juice, orange-juice, vinegar, etc. Follow by mucilaginous drinks. Stimulate if necessary, and give opiates for pain.
Antimony	Empty the stomach. *Tannic acid, gallic acid,* or *strong tea are antidotes.* Stimulate freely.
Arsenic	Empty the stomach. *Raw whites of eggs beaten in milk, precipitated ferric hydrate* or *magnesia are antidotes.* Follow by mucilaginous drinks, stimulation, and opiates.
Belladonna	Empty the stomach and stimulate.
Camphor	Empty the stomach and stimulate.
Cannabis indica	Empty the stomach and keep the patient aroused.
Cantharides	Empty the stomach. Follow by mucilaginous drinks. Give opiates for pain.
Carbolic acid	*Alcohol, Epsom* or *Glauber Salts are antidotes.* Later, give mucilaginous drinks and stimulate freely.
Chloral	Empty the stomach. Stimulate, and keep patient aroused. Perform artificial respiration if necessary.
Chloroform (taken internally)	Empty the stomach and try to arouse.
Chloroform, ether, and *nitrous oxide* (inhaled)	Place the head low and the feet raised. Perform artificial respiration and stimulate.

Poison.	Treatment.
Colchicum	Empty the stomach. *Tannic acid* or *strong tea are antidotes.* Later, give mucilaginous drinks, and stimulate.
Conium	Empty the stomach. Give strong tea, and stimulate.
Copper	Empty the stomach. *Potassium ferrocyanide* and *whites of eggs are antidotes.* Follow by mucilaginous drinks.
Corrosive sublimate	Empty the stomach. *The whites of eggs act as an antidote.* Follow by mucilaginous drinks and stimulation.
Croton oil	Empty the stomach. Give mucilaginous drinks, and stimulate.
Digitalis	Empty the stomach. *Tannic acid* or *strong tea are antidotes.*
Holly berries	Empty the stomach and stimulate.
Hyoscyamus	Empty the stomach, stimulate, and keep aroused.
Iodine	Empty the stomach. *Starch is an antidote.*
Iodoform (externally)	Stop the use of the drug and hasten its elimination by profuse sweating.
Lead	Empty the stomach. *Epsom* or *Glauber Salts are antidotes.* Follow by the use of mucilaginous drinks.
Mushrooms	Empty the stomach and stimulate freely.
Opium	Empty the stomach. *Potassium permanganate is an antidote.* Keep the patient aroused, stimulate, and perform artificial respiration if necessary.
Phosphorus	Empty the stomach. *Old French oil of turpentine is an antidote.* Use no other oils. Follow by mucilaginous drinks.
Poke berries	Empty the stomach, stimulate, and give mucilaginous drinks.
Ptomaine	Empty the stomach and stimulate.
Silver nitrate	Empty the stomach. *Salt is an antidote.*
Stramonium	Empty the stomach and stimulate.
Strychnine	Empty the stomach. *Tannic acid, strong tea,* or *charcoal are antidotes.* Perform artificial respiration if necessary.
Tobacco	Empty the stomach. *Tannic acid* or *strong tea are antidotes.*
Zinc	Empty the stomach. Give *strong tea, tannic acid,* or *bicarbonate of soda.* Follow by mucilaginous drinks and stimulation.

CHAPTER XX.

THE TRANSPORTATION OF THE INJURED.

The removal of a disabled person to his home, or to a place where he may be properly cared for, plays a considerable part in his immediate care. While human ingenuity may always find some means for accomplishing this in an emergency, yet, unless a person has some practical knowledge of the methods which can be used, it will usually be done in such a clumsy manner as to be exceedingly uncomfortable, if not actually harmful, for the sufferer. Every one who has seen accidents can recall occasions where a familiarity with the subject would have been of great assistance. In large towns or cities there are plenty of ambulances within call, and the duties of a "first-aider" end when he has rendered what assistance is possible. In the country, however, accidents may occur miles from help, with no available vehicle for transportation. To be alone with a disabled person far from any aid is a serious situation for any one, and the question of how to move him becomes a most troublesome problem, especially if the roads are rough or the country is mountainous.

The means of transportation may be divided into removal by hand, by chairs, on a stretcher, on a wheeled litter, by animals, or by ambulance, cart, or wagon, the choice of one method over the other depending upon the distance to be traveled and the help and apparatus available.

REMOVAL BY HAND.

By means of a single bearer (when the person is conscious and able to assist).

(1) **Simply assisting the patient to walk.**—If the person is suffering from only a slight injury which does not involve the lower limbs—as a fracture of the upper extremity or

simply weakness—stand upon one side of him and place your shoulder under his armpit, drawing his arm up over your shoulder, behind your neck, and across the opposite shoulder. His wrist is held in this position with the hand of the same side, while the arm nearest him encircles his waist. In this way he may be assisted to walk, his whole weight being supported should he stumble or fall. A person with a sprained ankle may be assisted in the above manner by supporting him upon the injured side and having him hop along without placing the injured foot upon the ground.

Fig. 218.—Method of assisting an injured person to walk.

(2) **Carrying pick-a-back.**—The patient stands up behind the bearer with one or both arms over the bearer's shoulders. The bearer then stoops down and, passing both arms behind him, grasps the patient's thighs firmly, drawing them forward on each side of his body; he then raises up and shifts him well up on his back. A person may be comfortably carried a long distance in this manner if his arms are uninjured and he can partly support himself by holding on to the bearer's shoulders.

(3) **Carrying in the arms** is a method only of use for moving a person a short distance or where the individual is not very heavy. The patient stands up, the bearer taking his position behind and supporting him. The bearer, stooping slightly, places one arm about the patient's waist and the other under his thighs and raises him to a sitting position in the arms, the patient aiding by clasping one or both arms about the bearer's neck.

By means of a single bearer (the patient being unconscious or helpless).

(1) **Carrying pick-a-back.** —A helpless person can be carried by this method only when there is help enough to place him upon the bearer's back. Lifted into the proper position, the patient is securely fastened in place by a rope, straps, belts, or a sheet, which passes around his back, under his arms, and up over the bearer's shoulders. It then crosses over the front of the bearer's chest, and passes around under his arms to the patient's back, where the ends are secured.

(2) **Carrying in the arms.**—The bearer supports the patient in a sitting position, and, kneeling beside him, places one arm about his waist and the other under his thighs. Then, by raising up, he lifts the patient into his arms. This method

Fig. 219.—Raising an unconscious or helpless person from the ground.

of lifting, however, is only possible where the person is not heavy. An ordinary man could not raise a heavy person more than a few inches from the ground in this manner. For the majority of cases the following method will have to be employed:

First, turn the patient flat on his face upon the ground; then, stepping astride his body and facing toward his head, place the hands under his armpits and lift into a kneeling position. The hands should now be quickly slid down under the patient's abdomen, when he can be raised to his feet. The bearer should support the patient in the erect position and place himself so that his left side will be toward the patient's

Fig. 220.—Lifting into the arms.

right, with the patient's right arm falling about his neck. To lift into the arms, the bearer stoops down, passes his left arm around the patient's waist, places his right arm beneath his thighs, and, straightening up, lifts him into his arms (Fig 220).

(3) **Carrying with the patient across the bearer's back.**—The patient is raised to a standing position as described above. The bearer then shifts himself to the front of the patient and with his left hand firmly grasps the patient's right hand, drawing the arm around his neck, over his left shoulder, and down across his chest. Then stooping over, the bearer encircles the patient's thighs or the right thigh, if both cannot be managed, with his right arm and, at the same time, seizes the patient's right wrist with the same hand. With his left hand, which is now free,

Fig. 221.—Method of lifting across the back.

Fig. 222.—Carrying with the patient across the back.

the bearer seizes the patient's left wrist. On rising, the patient's body will fall across the bearer's back.

(4) **Carrying with the patient across the shoulder.**—This method has an advantage over the others in that it leaves one of the bearer's hands free, a matter of great importance if obstacles have to be crossed or a ladder mounted. It is sometimes spoken of as the "firemen's lift," because used by them in carrying an unconscious person from a burning building.

In lifting by this method, the bearer turns the patient face downward as before, but now places himself at the patient's

Fig. 223.—Raising a helpless person from the ground preparatory to lifting across the shoulder.

head, facing him. He passes his hands under the patient's armpits and lifts him to his knees. The hands should then be shifted lower down and clasped behind the patient's back. With this grip, the patient may be raised to a standing position. The bearer supports the patient while he stoops down and places himself so that his right shoulder comes under the patient's abdomen, the upper part of the patient's body lying over the shoulder. The bearer then grasps the patient's right wrist in his left hand and brings it down and around under his left arm from behind, while he passes his right arm around the two thighs, if it be a woman with skirts, or, if it be a man, simply around the right thigh, and then shifts the patient's right hand so that it is clasped by the hand which encircles the thighs. The bearer then rises. By this method the patient will be securely held over the bearer's right shoulder, and the bearer's left arm will be entirely free (Fig. 225).

Fig. 224.—Method of lifting across the shoulder.

Fig. 225.—Carrying with the patient across the shoulder, the bearer's left arm being free.

By means of two bearers. (1) **The two-handed seat.**—The two bearers kneel upon opposite sides of the patient near his hips, and raise him to a sitting position. Each then passes one arm around the patient's back and the other under his thighs, the bearer on the patient's right grasping with his right hand the left wrist of his companion, the bearer on the left grasping with his left hand the right wrist of the first bearer. Both then rise slowly from the ground, and may shift their disengaged hands to each other's shoulders, thus forming a back rest for the patient; or, unless helpless, the patient may support himself by placing an arm around the neck of each bearer.

(2) **The three-handed seat.**—The two bearers stand upon opposite sides of the patient. One of them—the bearer upon

the patient's right, for example—grasps with his right hand his own left wrist, and with his left hand the left wrist of the other bearer. The bearer on the left grasps with his left hand the right wrist of the first bearer, and with his disengaged right hand grasps the first bearer's shoulder, thus forming a rest for the patient. Both bearers stoop down and slip the seat under the patient, he assisting by placing an arm about the neck of each and raising himself up while the seat is being placed under him. This method is not applicable to patients who are helpless or unconscious.

Fig. 226.—Carrying by the two-handed seat.

(3) **The four-handed seat.**—Each bearer takes his position as before, grasping his own left wrist with his right hand and

Fig. 227.—Three-handed seat.

Fig. 228.—Four-handed seat.

his partner's right wrist with his left hand. The patient sits or is placed upon the seat thus formed, and must support himself by encircling each bearer's neck with one arm. It is not suitable for patients with injuries about the upper extemities.

(4) **Carrying by the extremities.**—One bearer takes his place at the patient's head and raises him to a sitting posture. He then passes his arms under the patient's armpits, clasping his hands in front over the chest. The other bearer takes his position between the patient's thighs, grasping one thigh just above the knee in each arm. Both should rise together, lifting the patient into a horizontal position. This is a good method for transporting very weak persons without a stretcher.

Fig. 229.—Carrying by the extremities.

(5) **Improvised seats.**—In cases where a patient has to be carried a considerable distance, the hands of the bearers soon become tired and cramped in the above methods. To avoid this, a seat may readily be improvised from a board or from a rope, straps, towels, bandages, or other material tied in the form of a ring, upon which the patient sits, it being held by a bearer on each side. If the patient can assist in supporting himself, the bearers carry the seat with the hands nearest the patient; otherwise, they use the outer hands, their free hands supporting the patient.

Another form of seat may be made by cutting two poles, each about four feet long, and fastening to them two broad strips of any strong material at a distance of about one and a half feet from each other. The patient sits upon this seat with his legs hanging over the side poles and his back resting against the rear bearer.

REMOVAL BY CHAIRS.

By substituting a chair for the hand-seat, a person may be moved (by two bearers) in a sitting or semirecumbent position far more comfortably for both bearers and patient. Any strong chair will do.

Having placed the patient in the chair, the two bearers stand at either side and, stooping down, grasp the front legs or lower rungs with one hand and the back of the chair with the other. They then rise together, tipping the chair backward somewhat so as to distribute the weight more evenly between the two arms. In carrying a loaded chair upstairs always have the back go first.

REMOVAL ON STRETCHERS.

A stretcher is simply a light form of bed for transporting a disabled person who, from the character of his injuries, or on account of his condition, must remain in a recumbent position. Usually two bearers are all that are needed for carrying the stretcher,—one to bear the head end and one to bear the foot, though in some cases one or two extra persons may be required to watch the patient or aid the others in carrying.

There are any number of different kinds of stretchers manufactured, but the principles upon which they are constructed are in the main the same. All stretchers should be light, strong, and of such construction as will permit them to be easily folded when not in use, and also allow them to be readily cleaned.

The following description should give an idea of what is required: The framework consists of two poles, each seven and a half to eight feet long, which are square except at the extremities, where they are rounded off to form handles. The two poles are kept the proper distance apart—about twenty-two inches—by means of transverse iron braces placed near either end, consisting of two pieces joined in the center to form a scissors-like joint, which closes inward to allow the poles to be drawn together and the stretcher to be folded when not in use. Between the poles is stretched a width of canvas six feet long, which forms the stretcher bed. The stretcher is supported upon four legs, each about four inches high, made

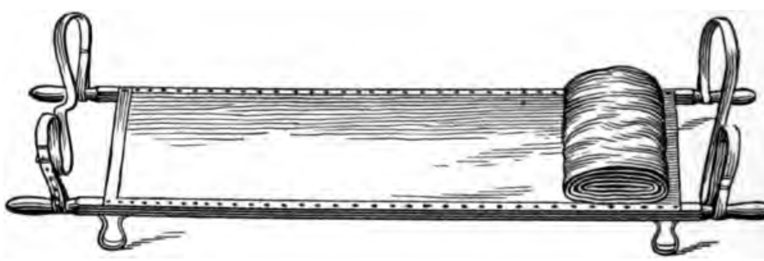

Fig. 230.—The Army stretcher (opened).

from iron or from round pegs of wood which are screwed into the poles. Beneath the canvas and stretching between the two poles at either end are two narrow straps which are used to fasten the stretcher poles together when folded and not in use. In some cases, as with the army stretchers, slings are provided which pass over the bearer's shoulders and help to take some of the weight from the arms. The slings consist of strong pieces of webbing or leather straps about two inches wide, with a loop at each end through which the handles pass; one of these loops is supplied with a buckle so that the length of the sling may be regulated to fit the bearer.

To put away or fold such a stretcher the transverse pieces are broken inward and the poles pushed together, the canvas bedding being raised from between them. The canvas should then be tightly rolled around the poles, the slings laid on top, and the whole affair securely fastened by passing the small straps previously mentioned around the poles and through the loops of the slings.

Improvised stretchers.—With the above description in mind of what is required for a stretcher, it should not be a

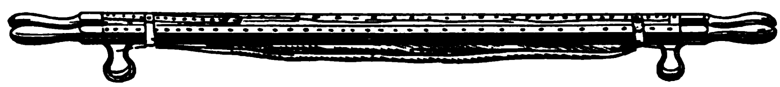

Fig. 231.—The Army stretcher (closed).

difficult matter for anyone to contrive some sort of an affair, should the circumstances demand it. Some of the many stretchers that may be improvised are made as follows:

The blanket stretcher.—Two strong poles should be cut to the proper length,—narrow fence-rails, limbs of trees, or small saplings will answer; a blanket or rug is then placed upon the ground, and the poles rolled from each side in the edges of the blanket until the portion remaining unrolled is of sufficient width for a stretcher bed. The stretcher may be

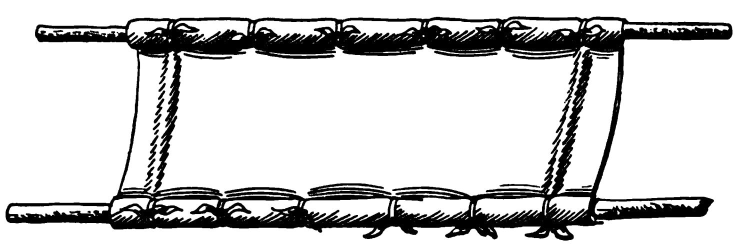

Fig. 232.—A blanket stretcher.

made more secure by wrapping cords about that portion of the blanket surrounding the poles, the cords passing through holes made in the blanket along the inner edges near the poles. Two sticks or pieces of board should be fastened at either end of the stretcher bed to hold the stretcher poles the proper distance apart.

The **sack stretcher** is made by using two sacks for the stretcher bed,—grain sacks, potato sacks, or strong pillow-cases will answer. The poles pass in at the mouths of the sacks and on out through holes cut in the bottom corners.

The **coat stretcher** may be made from two or three coats or vests, or from a single large overcoat. The sleeves of

Fig. 233.—Stretcher improvised from coats (inverted to show the manner in which it is made).

the coats are turned inside out, and through them are passed the two poles. The flaps of the coats are then turned down around the poles and buttoned underneath.

Gun stretchers.—Instead of poles the framework of a stretcher may be improvised from two shotguns or rifles, any of the above materials being utilized for the stretcher bed. The muzzles of both guns should point in the same direction, the trigger guards being uppermost. Of course, a loaded gun or one with cartridges in the magazine should never be used.

Hammock stretchers.—A hammock, if available, is an excellent form of stretcher. The two ends of the hammock are fastened to a long pole which is carried upon the shoulders of two bearers.

In addition to the above, benches, tables, mattresses, window-shutters, doors, and boards may be employed as stretchers. To form a stretcher bed, where the materials already suggested cannot be obtained, ropes, cords, wire, straps, suspenders, belts, or bandages may be interlaced betweeen poles or guns and covered with straw or hay.

To lift an injured person on to a stretcher.—Before attempting to remove an injured person always perform the necessary first-aid treatment, such as stopping hemorrhage, dressing wounds, putting on splints, etc. And remember to handle the patient with extreme care and gentleness. Never lift a person with a fractured limb from the ground unless the limb is supported in such a manner that no strain will be thrown upon the broken fragments. The stretcher should, if possible, be placed at a short distance from the head of the patient in line with his body; if space will not permit of this, it may be laid down beside the patient.

(1) **To lift with two bearers.**—The bearers take their positions upon the injured side of the patient, one at his hips and one at his knees. The first one then inserts his hands beneath the patient's shoulders and back, while the second one passes his arms beneath the thighs and calves. They should both rise together and carry the patient over the foot of the stretcher, head first.

When the stretcher has to be placed at the patient's side, the bearers take positions at the head and feet of the patient. The first one stoops down and passes his arms around the patient's chest and under his shoulders, firmly locking the fingers. The second bearer takes his place at the patient's knees, passing his arms around the thighs just above the knees. Both then rise together and transfer the patient to the stretcher.

(2) **To lift with three bearers.**—Two of the bearers kneel on one side of the patient, one passing his hands and arms beneath the patient's shoulders and back, the other beneath the calves and ankles. The third bearer places himself upon the opposite side, supporting the patient's thighs and back. All three bearers rise together and transfer the patient to the stretcher, head first over its foot; or the patient is lifted by all three bearers, and, while supported upon the knees of the two who are upon the same side, the third bearer gets the stretcher and places it in position beneath the patient.

(3) **To lift with four bearers.**—Three bearers kneel on the same side of the patient. The first passes one arm beneath the patient's shoulders, the other arm supporting his neck; the second passes his arms beneath the back and thighs; the third passes one arm beneath the calves and one under the

ankles. The fourth bearer kneels down upon the opposite side, passing his arms beneath the patient's back and thighs. All lift together and place the patient upon the knees of the first three, while the fourth bearer brings the stretcher and carefully inserts it beneath the patient.

Instead of the above maneuver, two bearers kneel upon each side of the patient, facing each other. Two pass their hands beneath the patient's shoulders and back, and the other two beneath the thighs and calves, the opposed bearers interlocking their fingers. They then rise together and transfer the patient to the stretcher. In unloading, the maneuvers are to be reversed in all cases.

To lift an injured person from stretcher to bed.—If the bed is narrow, the stretcher may be placed at its foot, head first. The bearers then arrange themselves, according to the number, in the manner described above, and lift the patient, carrying him head first over the foot of the bed.

If the bed is too wide for the bearer to carry the patient over its foot or if there is not sufficient room to place the stretcher in line with the bed, it may be placed at the side. The patient is then lifted, with two or three bearers upon the side farthest from the bed and one bearer upon the opposite side, as described above; and, while he is supported upon the knees of the bearers who are upon the same side, the extra bearer removes the stretcher and steps aside, allowing the others to place the patient upon the bed.

Carrying the stretcher.—In transporting a disabled person upon a stretcher there are certain rules to be observed for the comfort and safety of the patient.

As a general rule the patient should lie upon the stretcher with the feet pointing in the direction to be traveled. If a person is faint or suffering from shock or collapse, have the head lower than the feet; with an injury accompanied by great difficulty in breathing, however, the head and chest should be slightly elevated.

Always keep the stretcher as near the ground as possible, carrying it at arm's length. It should never be carried upon the shoulders of the bearers, for, should they stumble, the patient might receive a dangerous fall.

Walk out of step to avoid swinging the stretcher, which jars the patient. For the same reason, and because the patient might be thrown off, never run with a loaded stretcher.

Have the stretcher kept as nearly level as possible. In ascending or descending a hill or incline, the front bearer (if descending) or the rear bearer (if ascending) should raise his end sufficiently to keep the stretcher on a level. The head of the stretcher should never be lower than the feet except in a fracture of the lower extremity or in the conditions mentioned above, and for this reason the tallest bearer, and likewise the strongest, should always carry the head end, as this end is the heaviest. In lifting the loaded stretcher from the ground, raise the head end slightly in advance of the foot.

With the lower extremity fractured, place the patient upon his back on the stretcher. Carry feet foremost in going uphill and head first downhill to prevent the weight of the body by any chance pressing down upon the injured limb.

Do not attempt to cross a ditch, stream, wall, or fence with a loaded stretcher, if it can be avoided. Rather tear down the obstacle, or even make a longer journey if necessary. In any case it is dangerous to try to cross any obstacle without at least three or, better still, four bearers, the extra ones standing beside the stretcher to assist in elevating or lowering it, and at the same time to prevent the patient from falling off.

If it is necessary to cross a fence or wall—and it should not be attempted if the obstacle is over seven feet—the extra bearers stand beside the stretcher if the obstacle is low and assist in elevating it sufficiently to place the foremost end upon the top of the obstacle. The stretcher is maintained in this position, the extra bearers aiding the rear bearer in supporting it until the front bearer climbs the obstacle and takes hold of the foremost end. The extra bearers then climb the obstacle and the stretcher is carried forward until the rear end rests upon the top of the obstacle. The rear bearer finally climbs over and the stretcher again advances. An obstacle may be crossed by the same maneuver, using two bearers at each end of the stretcher instead of any assistance from the sides. This latter method should be used in crossing high fences or walls.

In crossing a ditch or stream, the stretcher is laid upon the ground with its foot near the edge. If the distance is not wide,

Fig. 234.—Method of crossing a high fence or wall.

the two front bearers enter the ditch or stream and, aided by the other bearers, carry the foremost end of the stretcher to the opposite side. The two first bearers then get out of the ditch and take care of the front end of the stretcher, while the rear bearers enter the ditch and help to lift the stretcher to the opposite bank. The rear bearers then leave the ditch and again take up the rear of the stretcher. If the distance to be crossed is very wide, the two first bearers enter the ditch and the stretcher is advanced as before until its rear end rests upon the bank, the front end being supported by the first bearers. The two rear bearers then enter the ditch, and the stretcher is advanced to the opposite bank, upon which the foremost end is placed. The two first bearers then climb out and take hold of the front handles of the stretcher, while the rear is held by the rear bearers. The remaining maneuvers are the same as for crossing a narrow ditch or stream.

A stretcher should be carried upstairs head first. One bearer supports the front end, while two hold up the rear end, raising it high enough to keep the stretcher on a level. A fourth bearer should remain at the side of the patient to prevent him from falling off. In descending stairs, the foot of the stretcher is carried first and the positions of the bearers are reversed, that is, two bearers support the front end and one the rear.

To raise or lower a stretcher where it is impossible to use bearers.—At times it is necessary to move a person up the side of a steep cliff, up the side of a ship, or out of an excavation, mine, or well. In an emergency, without suitable apparatus, a sling can be improvised by means of which the stretcher may be readily raised or lowered from above. Strong ropes are fastened to the four corners of the stretcher frame, converging toward each other and meeting at a point several feet above the stretcher. A supporting rope by which the stretcher is to be raised or lowered, or, better still, a pulley through which this rope can pass, is secured to the rope sling at a point that will keep the loaded stretcher level when raised. The bed of the stretcher should be longer than ordinarily required—at least seven feet long—and the patient should be securely fastened to it, so that he will not fall out, even though the stretcher be turned on end. For this purpose a strong piece of blanket, canvas, or a folded sheet should be passed across his body and secured to the stretcher poles, firmly binding him to the stretcher. In like manner the shoulders should be strapped down and the legs securely fastened by strips passing around the thighs and ankles. In all cases plenty of help will be needed to raise or lower the stretcher.

If it is necessary to raise a person through a narrow opening, he may be securely fastened to the stretcher as described

Fig. 235.—Raising an injured person up a cliff.

above and raised in an upright position, the feet being lowermost. For lowering or raising an injured person through ship hatches, a special stretcher, known as Gihon's cot (Fig. 236), has been devised. Should the condition of the patient be such that he can remain sitting up, a seat or strong chair may be fitted with a sling, and the patient be raised or lowered in a more comfortable manner.

REMOVAL ON WHEELED LITTERS.

A wheeled litter is simply a stretcher on wheels to be pushed or pulled by a single bearer. The litter usually consists of a hand stretcher mounted upon a light frame, which is supported upon wheels. Springs should always be provided, and props should be secured at either end, which can be lowered and so support the litter when standing alone. The stretcher must be built in such a manner that it can be removed and replaced at will, because the patient should never be lifted from the ground to the litter. Instead, the stretcher should be placed beside the patient and, when loaded, replaced upon the frame. In an emergency, a wheelbarrow is sometimes utilized for the same purposes.

Fig. 236.—Gihon's cot for ship's use; patient ready to be lowered through a hatch or into a boat.

Wheeled litters are of no practical value in a rough country. They can only be used upon smooth roads. They are, however, frequently used in small towns which do not possess ambulances, and for this reason have been mentioned.

REMOVAL BY ANIMALS.

If horses or mules are available, a disabled person may be transported in as comfortable a manner and certainly more rapidly than by human bearers. This means of transportation is especially useful when a long distance has to be traveled over rough country; and on mountains or over treacherous and dangerous trails there is no better means of transportation than by sure-footed mules.

The **two-horse stretcher** consists of an ordinary stretcher, to the front and rear ends of which is hitched a horse or mule. The side poles of this stretcher should be sixteen to seventeen feet long and wide enough apart at each end to permit the

Fig. 237.—Stretcher carried by two mules.

animal to be hitched between them. Two and a half to three feet will give sufficient space for a good-sized animal. The ends of the poles are securely fastened to the saddles, and if the animals are provided with pack-saddles so much the better. One or two men will be required to lead the animals and another to guard the patient.

The **travois** is a stretcher drawn by a single animal, the rear end dragging upon the ground. It consists of two poles about sixteen feet long, the front ends being fastened to the saddle of a horse or mule, while the rear ends drag on the ground. One pole may be cut several inches shorter than the other to avoid jolting the patient in passing over small obstacles or any unevenness in the road. The poles at the front end of the travois should be about two and a half feet apart and at the rear end about three feet apart, kept in this relative position by two cross-pieces, each of which is secured to the side poles at a distance of about six feet from the other. Between the two poles and cross-pieces the stretcher may be suspended by ropes, straps, etc., or a stretcher bed may be improvised from ropes, blankets, sacks, or coats, a detailed description of which has been previously given. One man will be required to lead the horse or mule, and another one should be posted at the rear of the travois to raise the end in passing any obstacles such as streams, rocks, or stumps.

Fig. 238.—An improvised travois.

The two-horse stretcher and travois should never be loaded until the animals are properly hitched, and should always be unloaded before unhitching.

Cacolets are simply chairs suspended from a pack-saddle and are only suitable for patients who can sit up or partly recline. One chair is securely fastened upon each side of the animal, facing the animal's head. If one patient only is to be carried, sufficient weight must be attached to the opposite side to keep the saddle from turning.

REMOVAL IN AMBULANCE, CART, OR WAGON.

Ambulances are four-wheeled conveyances with springs, fitted up especially for the transportation of the disabled, and supplied with stretchers, necessary drugs, dressings, splints, and surgical appliances. For use in large cities where the roadways are good and where it is usually necessary to transport but a single patient at a time, the ambulance is constructed with the idea of providing a light and easy-running vehicle, which at the same time will permit of speed. As a rule they are drawn by one horse and are capable of comfortably carrying but one person in a recumbent position, but with crowding may accommodate two. The wheels of many of the modern ambulances are fitted up with ball bearings and rubber tires.

At one time the light ambulance was tried in the Army but proved unsatisfactory. Over rough roads there was too much jolting for the patients, and the vehicles did not last long. At the present time a much heavier, larger, and stronger vehicle is used, requiring at least two horses to draw it. It has room enough to accommodate two patients recumbent and several more sitting. Being provided with strong, stout springs, it is well adapted for rough country.

Whenever it becomes necessary to transport a person in an ordinary wagon or cart, obtain one large enough to accommodate the patient without cramping him, preferably a vehicle with springs. *Never attempt to move a person suffering from a fracture of the lower limbs in a hansom or cab.* He should have enough room to keep the injured limb extended. To furnish a certain amount of springiness in a wagon not supplied with springs, a number of thin boards or elastic poles should be placed across the top of the wagon or cart-body. Slender green saplings will answer for this purpose. Upon the top of these improvised springs is placed the stretcher, securely lashed to the wagon body. Where nothing better can be obtained, the floor of the wagon or cart may be covered with hay, straw, leaves, or boughs upon which the stretcher rests. If this is done jars or jolts will not be felt with as much force by the patient.

To lift a stretcher into a vehicle.—The stretcher should always be loaded into the back of the vehicle, not lifted sideways over the wheels. As a rule, the head should go foremost, unless the vehicle is lower in front than behind. Two bearers place themselves on each side of the head of the stretcher and two grasp the foot, and all lifting together place the head of the stretcher in the vehicle. One bearer now gets into the vehicle and takes hold of the front end, another supports the rear, and the other two stand upon the sides of the stretcher grasping the two poles. All lift together and advance the stretcher into the vehicle.

In removing a stretcher, the above order of proceeding is simply reversed.

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